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Tone Production on the Piano: The Research of Otto Rudolph Ortmann

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Tone Production on the Piano:
The Research of Otto Rudolph Ortmann

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Dedication

This treatise is dedicated to my husband, José Ramón Méndez, and to my former teacher Miyoko Nakaya Lotto. Two of the most special people in my life, they both have had a profound effect on my understanding of piano playing.

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The University of Texas at Austin, 2007

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The purpose of this treatise is to discuss tone production on the piano, specifically focusing on the research of Otto Rudolph Ortmann, whose work marked a turning point in the history of piano pedagogy and set a new standard for piano-related scholarship. Writing in the early twentieth century, Ortmann, who was both an accomplished pianist and an avid scientist, was one of the first to consciously and meticulously combine the two fields. Today, Ortmann's books are mostly out of print and his research is little known by the average piano student or teacher. However, Ortmann's books greatly affected and influenced many of his contemporaries, and no matter how neglected today, they contain a wealth of information and practical advice highly relevant to any serious pianist. While his research spans a range of topics, including the science of piano acoustics, experiments and scientific explanations of piano technique, and even music education, his work focusing on piano tone production was perhaps the most

controversial. In this treatise, Ortmann's concepts, experiments, and conclusions related to tone production will be discussed. Certain scientific elements related to tone production, such as the acoustics of sound, the mechanism of the piano, and the relevant aspects of basic physics, will serve as an introduction to this discussion. A historical overview of the pedagogical trends surrounding the subject will show how Ortmann's work has been sometimes overlooked and often misinterpreted. A thorough analysis of Ortmann's research will demonstrate its balanced approach and its indispensable relevance to the modern pianist and pedagogue. Finally, his work will be used as a vantage point to shed light on subsequent trends of piano pedagogy and to ask questions about the role of tone production in modern pianism.

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No language is so difficult to understand as the language of tones. Music, in this respect, differs from all other arts: its transiency keeps its nature obscure and makes its effects subtle. As a result, truth and error, fact and fancy, have long played a game of hide-and-seek in musical theory.

Otto Rudolph Ortmann, *The Physical Basis of Piano Touch and Tone*

Introduction

The purpose of this treatise is to discuss tone production on the piano, specifically focusing on the research of Otto Rudolph Ortmann, whose work marked a turning point in the history of piano pedagogy and set a new standard for piano-related scholarship. Writing in the early twentieth century, Ortmann, who was both an accomplished pianist and an avid scientist, was one of the first to consciously and meticulously combine the two fields. Today, Ortmann's books are mostly out of print and his research is little known by the average piano student or teacher. However, Ortmann's books greatly affected and influenced many of his contemporaries, and no matter how neglected today, they contain a wealth of information and practical advice highly relevant to any serious pianist. While his research spans a range of topics, including the science of piano acoustics, experiments and scientific explanations of piano technique, and even music education, his work focusing on piano tone production was perhaps the most controversial. In this treatise, Ortmann's concepts, experiments, and conclusions related to tone production will be discussed. Certain scientific elements related to tone production, such as the acoustics of sound, the mechanism of the piano, and the relevant aspects of basic physics, will serve as an introduction to this discussion. A historical overview of the pedagogical trends surrounding the subject will show how Ortmann's work has been sometimes overlooked and often misinterpreted. A thorough analysis of Ortmann's research will demonstrate its balanced approach and its indispensable relevance to the modern pianist and pedagogue. Finally, his work will be used as a vantage point to shed light on subsequent trends of piano pedagogy and to ask questions about the role of tone production in modern pianism.

PART ONE: ACOUSTICS AND THE PIANO

Chapter 1: Basic Acoustics

Before sound production on the piano is discussed, a brief discussion of sound in general is necessary. We begin with the basic question: What is sound? Sound is actually made up of vibrations in the form of waves, which are the disturbance of surrounding air molecules.[1] These vibrations are interpreted by our ears as sound. Many kinds of waves behave in a similar manner, and sound waves are no exception. The speed of any wave is determined by the distance traveled by the wave divided by the travel time. The distance between any two corresponding points on a wave is referred to as wavelength. The amplitude of a wave is the distance from the mid-point of the wave to the maximum point of displacement. This is demonstrated in the simple diagram of a wave in Figure 1. The frequency of any wave is defined by how many periods of the wave are completed in one unit of time, or how many cycles per second.

Sound waves cause compressions and rarefactions in the material through which they travel. In other words, when a sound wave travels through a material, the molecules that make up the material will continually contract and expand. The human ear acts like a receiver to these compressions and rarefactions. When a compression of air molecules hits the eardrum, it exerts a high pressure on the eardrum and causes it to move slightly inwards. The next rarefaction causes the eardrum to move in the opposite direction. These vibrations are translated into electrical signals by the inner ear and sent to the brain, which then interprets them as sound.

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[1] It is important to note that sound waves are not entities in and of themselves; rather, they consist in the disturbance of a medium, whether it be a gas, liquid, or solid.

Obviously different sounds have different intensities. The intensity of a sound wave can be defined as the amount of sound power in a given unit area, or the amount of energy passing through one square meter in one second. The metric unit of sound intensity is Watts/m^2. More commonly, however, the decibel scale has been used to determine sound intensity. A very soft sound, such as a whisper, is about 20 decibels, and the loudness of someone's voice in a normal telephone conversation is about 60 decibels. Sound becomes painful to the human ear at about 120 decibels. Distance to the proximity of the sound source must also be considered in intensity. The intensity of the sound is inversely proportional to the square of the distance away from the sound source. In general, what we understand as the loudness of a sound increases as the intensity of a sound increases. But it is critical to distinguish that intensity is a precise measurement, whereas loudness is a subjective interpretation.[2]

The speed of sound moving through air is about 340 meters per second, or 1100 feet per second. In other materials, the speed of sound varies. In fact, the speed of sound even changes slightly with varying temperatures and humidity levels. Sound waves travel faster in warm air than in cold air. When sound waves travel through air of different temperatures, for example, in a two-story house where the warm air rises to the second story, the sound waves will change direction in a phenomenon called refraction. This can happen in any material so long as the sound waves are forced to travel at an angle due to different travel speeds. Nonetheless, refraction does not change the frequency of the sound.

Other changes that can occur to sound waves are diffraction and interference. Diffraction of sound occurs when sound waves are bent by going around a corner. While

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[2] As noted by Karl Kuhn, *Basic Physics: A Self Teaching Guide*, 2nd Ed., (New York: John Wiley and

in refraction sound waves continue in a new direction, in diffraction only a portion of the wave continues in a new direction. Interference is a phenomenon in which two sound waves are combined. Interference can either be constructive or destructive. In constructive interference, two waves in phase with each other would combine and cause an increase in loudness and intensity. In destructive interference, the waves would be out of phase with one another. If two waves of the same amplitude were perfectly out of phase with one another, in other words, if each had the exact opposite phase of the other, the two sounds would cancel each other out.[3]

The last two components of sound that need be incorporated here are pitch and quality. Pitch is the interpretation by which our brains distinguish sounds by differences of tone. Pitch generally corresponds with frequency. Like the difference in loudness and intensity, pitch is a subjective interpretation and difficult to measure, while frequency is a calculable quantity.

Few sounds are made up of pure, regular sound waves like the one in Figure 1. In fact, most sounds are made of combined frequencies. The quality of a sound has to do with the number and intensity of overtones. This is why, for example, the same note played on a violin and a harp will have the same pitch, but the difference in quality will allow the listener to distinguish between them.

While the description above is just introductory and is simplified for the purposes of this treatise, it does provide a foundation to begin our investigation of piano tone. In the following chapters, further discussion of acoustics as directly related to piano playing and piano tone will be included as necessary. Now that the basic foundational principles

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Sons, 1996): 124.

[3] This condition is actually quite difficult to achieve in practice.

have been laid down, we can begin our discussion of how sound is produced on the piano and how the inherent aspects of the instrument affect tone production.

Chapter 2: Innate Qualities of the Instrument

What one sees on the outside of a piano, its case and lid, have in fact very little to do with the tone quality of the instrument. The case is what holds the mechanism of the piano and the raised lid helps to project the sound into the room. If closed, the lid does not greatly affect tone quality; it only reduces the overall amount of the instrument's sound. It is important to note that much sound comes from the open underside of the instrument.

Inside the case, we have what concerns the tone quality: the mechanism of the piano itself. There are many ways to describe and classify the inner workings of the piano. However, perhaps the most clear is to classify the parts of the instrument using Edwin Good's terminology from his book *Giraffes, Black Dragons, and other Pianos*. Good divides the inside of the piano into three parts: the vibrator, the resonator, and the activator. [4]

The vibrator is the set of strings. The material used for the strings is steel, which is due to its relative flexibility as compared to other metals.[5] The lowest eight strings are wound tightly with copper, and there is only one string per note. The following eighteen are also wound with copper, but have two strings per note. The rest have three strings per note, and these strings are exclusively steel.

As one can see by looking inside a piano, the strings become shorter and thinner as they enter the treble register. All the strings are stretched to a certain tension in order to produce pitches that are audible to the human ear. Each individual pitch is determined

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4 Edwin Good, *Giraffes, Black Dragons and Other Pianos*, 2nd Ed., (Stanford, CA: Stanford University Press, 2004).

5 Otto Ortmann, *Physical Basis of Piano Touch and Tone*, (New York: E.P. Dutton, 1925), 7.

by the string's rate of vibration, which depends on the combination of length, tension, and mass (or thickness) of the string.

There are three scientific laws which govern vibrating strings, often referred to as the Laws of Strings. The first states that when a string and its tension remain unaltered, but the length is varied, the period of vibration is equal to the length. This law was already formulated around 525 B.C. by Pythagoras, possibly the first person to combine the fields of music and science. The anecdote of Pythagoras experimenting with different lengths of strings to produce different pitches is probably found in every textbook on music.[6] The second law maintains that when a string and its length remain unaltered, but tension is varied, the frequency is proportional to the square root of the tension. The last law states that for different strings of the same length and tension, the period of vibration is proportional to the square root of the mass of the string. All of these formulas must be considered in piano design, which will be discussed further below.

As mentioned in the previous chapter, the rate of vibration is also known as frequency. The unit used to measure frequency is Hertz, usually abbreviated Hz.[7] For example, if a string vibrates at 100 cycles per second, it is said to have the frequency of 100 Hertz. The ratio of an octave is represented as 2:1. For example, if one note vibrates at 200 Hz, its corresponding note an octave lower will vibrate at 100 Hz. Because of the first law of strings, following these ratios with the appropriate pitches of the piano and at the same time keeping the strings the same thickness, the piano would have to accommodate strings over twenty feet long. For this reason, the strings must become

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[6]Pythagoras was responsible for many other scientific concepts important to musicians. Most specifically to the construction of pianos is the Pythagorean theorem of right triangles: that the "square of hypotenuse is equal to the sum of the squares of the lengths of the other two sides," which is used to calculate the bearing in pounds with which a piano string pushes against the bridge.
[7] After the German scientist, Heinrich Hertz, who is credited as the first to measure electromagnetic waves.

thicker towards the bass region. In other words, "strings become longer as the pitches go lower, but not in the proportions necessary if they did not also become thicker."[8]

The strings not only vibrate across their entire length, but also at other points along the string, which being only portions of the whole, naturally produce higher frequencies. These are often referred to as overtones but are more precisely defined as partials. On a hypothetical instrument, these higher frequencies would be perfectly in tune with their original counterpart, or fundamental, and thus would be true overtones. But on actual piano strings, which are not perfect, these higher frequencies are extremely out of tune with their fundamentals, so much so that piano technicians are forced to compensate. This is a phenomenon known as inharmonicity. These partials must be allowed in certain proportions to optimize the sound quality. If too many partials are allowed, the sound will be harsh and shrill; if they are done away with completely, the sound will lack luster.

Many factors affect the timbre of the sound. First and foremost, the steel used to make the strings must be of high quality. The steel must have a consistent density all the way through, must have a perfectly round shape, and must not be prone to twisting. Also, the relationships between mass, tension and length of the string will affect the timbre. If in a certain instrument the strings are both short and thick, the resulting sound will not be as good as in one that allows for more length. This is why the concert grand has a more ideal sound than a smaller grand, or why, for instance, in some cases a large upright piano may have a more satisfactory tone than a baby grand.[9] The material of the activator (the hammers) will also affect the timbre of the sound. If the hammers are soft and compress easily, they will be in contact with the string for too long, in turn

[8] Good, *Giraffes, Black Dragons*, 7.

dampening out many of the upper partials. If the hammers are harder, they will strike the string with more precision and allow many of the upper partials to ring. W.V. McFerrin[10] likens this to the easily realized experiment of plucking a piano string first with the soft part of the finger and then with the fingernail. The former will cause the sound to be mellow and round; in the latter case, the resulting sound will be sharper and more brilliant.

The place on the string which the hammer hits also affects the timbre or quality of the tone. Along a vibrating string, there are points of relative rest (See Fig. 2). These are called nodes. If a hammer hits at a certain node, it will dampen out all the partials of the corresponding frequency. If the hammer hits a string in its center, for example, it will mute out all the even-numbered partials. The ideal place for the hammer to hit the string is somewhere between 1/7 and 1/9 of the speaking length of the string. This in turn cancels out the 7th, 8th and 9th partials almost completely, which seems to have a pleasant overall effect on the timbre. In light of all the factors described above, it is clear that by the very construction of the instrument, a piano builder already determines much of its inherent tone quality.

At one end, the strings are wound around pins, called tuning pins or wrest pins. It is in turning these pins that a tuner has the ability to raise or lower the pitch of each string. These pins are driven into a piece of laminated maple called the pin block. At the other end, the strings are wound around another set of pins, called hitch pins, which are

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9 Ibid, 10.

10 McFerrin, *The Piano – Its Acoustics*, (Boston: Tuners Supply Co., 1972), 45. With his background both in physics and experience as a piano technician, McFerrin offers a good reference for pianists with his solid but not overly complicated outline of the piano's acoustics. Interestingly, the book also contains a chapter entitled "Timbre or Tone Quality," one that is almost exclusively based on the research and findings of Otto Ortmann.

either driven in or cast directly into the metal frame. Much of the tension in the strings[11] is borne by this metal frame, which is a single piece of cast iron with holes over the pin block to accommodate the protrusion of the tuning pins. This frame is bolted into the pin-block and is also bolted to the wooden frame on the underside of the piano. In the treble register, the strings pass underneath a metal bar, called the *capo tasto* or *capo d'astro* bar.[12] The strings in the lower register pass through holes in the metal frame, called *agraffes*. Both these mechanisms hold the strings down so that the strings exert a small amount of pressure upwards. This fairly modern addition to the piano is useful for keeping the strings in place when the hammer strike approaches from below. It also aids in relieving some pressure from the pin-block. These two devices are vital. Not only do they determine one side of the speaking length of the string, but they also determine the upbearing of the string. This exactly establishes the angle at which the strings bear down on the bridge at the other end of their speaking length, an important factor in the resulting tone quality.

As mentioned above, at the other end of their speaking length, the strings pass over and bear down on a piece of laminated maple, called the bridge (See Fig. 3). This angle of downbearing (like the angle of upbearing on the *capo tasto*) also prevents the strings from dislodging. The lowest strings are strung across the higher strings, in a process called cross-stringing or overstringing. This aids in accommodating within the piano case the length of some of the lower strings. Also, due to the lower strings' relative flexibility, it adds to the richness of the tone by mixing in a greater combination of partials.

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[11] In a concert grand, string tension can be up to 30 tons.

[12] *Capo tasto* is Italian for 'top of the keys.' The bar is often called *capo d'astro*, or 'top of the star,' nomenclature that "sounds nice but means nothing." Good, *Giraffes*, 12.

At the bridge, the vibrator ends and the amplifier begins because the bridge transmits the vibrations to the soundboard. If a piano did not have a soundboard, the vibrating strings would cause the surrounding air to vibrate, but because a metal wire has a relatively minute diameter, the resulting sound would be small and thin. This is why, for example, a harp does not have a large sound. The piano makes use of the wooden soundboard which has a greatly increased surface area compared to a metal string. The increased surface area in turn sets more air into vibration, thus producing a much greater amount of sound. It is vital that all parts of the soundboard vibrate in the same phase; otherwise vibrations of different phases could cancel one another out by interference. This requires that the board be made of a wood in which sound travels relatively quickly. The wood used for the soundboard is spruce, in which sound travels at approximately three miles per second.[13] No other material has yet been found to be better. The spruce must be of a high quality, with a straight consistent grain and many age rings. The soundboard is made of thin laminated laths, which are glued together. The thickest point of the soundboard is about 3/8 of an inch thick, and at the edges it is thinner, about 3/16 of an inch. The taper is intended to overcome some inherent stiffness in the board, which hinders vibrations from traveling freely. The board also has a slightly convex shape – the highest part at the tip of the bridge – to ensure the most efficient reception of the vibrations from the bridge. Along the back of the soundboard run wooden supports or ribs. These are often said to affect tone quality, but their most important function is to hold the shape of the soundboard. There is great controversy over the design of the ribs and the direction of the grain of the soundboard, but it is clear that the soundboard's main task is to amplify the vibrations of the string.

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[13] Sir James Jeans, *Science and Music*, (Cambridge: Cambridge University Press, 1947), 100.

This brings us to the last of the three components of the piano mechanism: the activator, which is the action of the piano. Edwin Good points out that the German *die Mechanik* or French *le mécanisme* designations ("the mechanism") are perhaps more appropriate for what we call the "action" of the piano, because it is the most complicated of the three components and presents many innate problems of design. He states the problems of the piano's action:

> [The action's] job is both to set the strings vibrating and to stop or damp them. It must do so consistently, accurately, instantaneously, noiselessly, and for long times.[14]

He goes on to note that the action must be designed to correspond directly with the player's control of the key.

A diagram of the action can be seen in Figure 4. Although of course it would be much easier to understand how the action of a piano works by demonstration on an actual model, an attempt will be made to explain it here as clearly and concisely as possible. This diagram and explanation is modeled after Good's explanation of the action, which he calls "simplified" but is quite precise and clear enough for the purposes of this treatise.

When the visible part of the *key lever* (a) is depressed by the player, the other end rises. The *capstan* (b) is secured on the top of the key and pushes up against the *wippen* (c), one end of which connects to the *jack* (d), and causes the *check* (o) to rise. The upper end of the jack lies against the *knuckle* (e), which is mounted on the bottom of the *hammer shank* (f).

When the key moves up, the *jack* (d) pushes against *knuckle* (e) and thrusts the hammer to the string.[15] Simultaneously, the end of the key lever pushes up the damper

[14] Good, *Giraffes*. 17.
[15] The actual striking of the string cannot be seen with the naked human eye, because the hammer stays in contact with the string for only about 1/250th of a second.

mechanism (h, i), which raises the damper (j) from the string and allows the sound to ring.

At this point, the tail of the jack has met the small *regulating button* (l), which moves the jack behind the knuckle. The rising of the *wippen* (c) causes the *repetition lever* (m) to rise, whose top end rests on the phlange of the hammer.

When the hammer descends from the string, the knuckle pushes the repetition lever back down and the jack, protruding through a slot in the repetition lever, remains offset from the knuckle. The *hammer butt* (n) catches on the *check* (o) which rose with the key. The slightest release of the key causes the *check* (o) to release the *hammer* (k). The *repetition lever* (m) pushes the hammer shank up so that the *jack* (d) with help of the *jack spring* (p) retakes its original position.

In upright pianos, the action is basically the same, but the upright action has the added complication of having to fight against gravity. This is achieved mechanically, and as a result, upright actions are never as desirable as grand actions.

Escapement is an essential part of the modern piano action. The *jack* (d), having pushed against the *knuckle* (e) on the bottom of the hammer shank and thrown the hammer upward, is pivoted back by encountering the regulating button. This, along with the *check* (o), allows the hammer to fall back only part of the way, as long as the key is held. This way notes can be repeated rapidly, since the hammer has less distance to move. [16]

The hammer is the actual part of the action which comes into contact with the string. The hammers are larger for lower notes and smaller for higher notes. Felt is used for crafting the hammer heads, but it is not a perfect material. Extended usage hardens

[16] This "repetition action" was patented by Sebastian Érard in 1821 in Paris, France.

the felt, thus causing the sound to become more brittle (as mentioned above, harder strikes on the strings produce a sound with more partial overtones), and the hammers must be voiced or pricked with needles to remedy the problem. Also grooves are formed in the hammer heads with repeated use, so their tops must be frequently reshaped.

Another important part of the action is the damper mechanism. When the key is released, the damper falls back down to stop the vibrations. The material of the dampers cannot be heavy enough to cause unwanted noise, but must be heavy enough to stop the vibrations decisively. This is harder in the high registers. Even on fine instruments, the upper tones ring a little extra even if the key has already been released.

Finally, the pedal mechanisms, while not part of the action itself, are crucial to the piano. There are three pedals on the modern grand (See Fig. 5). First is the damper pedal, the one on the far right from the point of view of the player, which has a mechanism to keep all the dampers up and let each sound ring. The middle pedal, or *sostenuto* pedal, keeps only those dampers up which were already up when pedal was depressed.[17] The left pedal, or *una corda*, moves the action over so that the hammers hit only one or two strings instead of the usual two or three.[18]

[17] Patented by Alfred Steinway in 1874.

[18] Thus, the name *una corda* (Italian for 'one string') is really a misnomer. It is worth noting that this process does not work in upright pianos because the strings are so close together. If the action were shifted, the hammers might hit a string of the wrong pitch.

PART TWO: HISTORICAL BACKGROUND

Chapter 3: Piano Technology

By 1925, the year in which Ortmann published his first book, the piano had long since been almost identical to the modern grand piano. While only minor changes have been made since that time, countless developments were made in the two centuries before. In order to fully appreciate how the modern piano came into existence, we must closely examine the modifications and transformation that took place during the course of its development.

Although the piano's hammer-struck string action can be traced back to 1690 with the invention of the Pantalon,[19] a dulcimer-like instrument played with two hammers, the first appearance of an actual pianoforte was in the early 18th century. By 1709, the Italian instrument maker Bartolommeo Cristofori had built several instruments which he called the *Gravicembalo col piano e forte*, which means "harpsichord that plays soft and loud." The outside of these instruments was just like a large harpsichord, but Cristofori replaced the harpsichord plucking action with a struck action of hammers on the strings (See Fig. 6). Although contemporaries complained that the instrument's action was hard to manage and that the sound was muffled compared to a harpsichord, the action was strikingly similar to a modern piano. Cristofori invented a quite complicated mechanism that included an escapement action and a 'back check' to prevent the hammer from

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[19] The pantalon was an unusual instrument, one that consisted of one or two soundboards and two sets of strings made of cat-gut and steel. The instrument was invented by Pantaleon Hebenstreit in the late 17th century and was named by Louis XIV, perhaps as a double meaning, not only to mimic the name of its inventor, but also to connote the common French and Italian designation for "clown." (This is not a literal translation, but a recollection of the pitiable comic character in Commedia dell'arte.) The pantalon was extremely fashionable because of its wide range of dynamic capabilities, a range which was needed to properly interpret the new expressiveness in the music of the time. Sarah Hanks, "Pantaleon's Pantalon: An 18th Century Musical Fashion," *The Musical Quarterly* 55, no. 2 (1969): 215-227.

jamming against the strings and to allow for faster and more reliable repetition, a damper system to silence the strings, and even an *una corda* device – by sliding the keyboard sideways, the hammers would hit only two strings instead of the usual three.

Gottfried Silbermann, an organ and clavichord maker in Dresden, after discovering the German translation of Marquis Scipione Maffei's account[20] of Cristofori's instruments, began to make pianofortes of his own around the middle of the century. Silbermann did not use the hammer check that was present in Cristofori's action, but he did use a similar escapement action. In addition, he included hand stops to raise the treble and bass dampers as well as an *una corda* device. Even though Silbermann was turning out instruments with much more complex actions than his German contemporaries, he still faced criticism of the heavy and hard-to-manage action and a generally muffled sound. When J.S. Bach visited Dresden in 1736, Silbermann showed him the instruments, and Bach complained that they were difficult to play and were weak in the treble.[21] Silbermann worked for many years on how to solve this problem and built redesigned instruments that gained wider acceptance, but he never solved the issue to his satisfaction. Frederick II of Prussia bought several of Silbermann's redesigned models in 1746, and there is a well-known anecdote that J.S. Bach praised these new instruments upon a visit to the king. However, this praise should be taken with a grain of salt, as it would have been extremely rude for Bach to belittle his royal host's instruments.

Other German keyboard makers, especially Johann Stein and his son-in-law, Johann Streicher, were making advances in pianoforte construction. These Stein pianos

[20] Maffei's article first appeared 1711 in the fifth volume of the Venetian magazine *Giornale de' Letterati d'Italia* which was published quarterly. The article was translated by Johann Ulrich von Koenig and appeared in 1725 in *Critica Musica*, a collection of musical essays by John Mattheson. Arthur Loesser, *Men, Women and Pianos*, (New York: Simon and Schuster, 1954): 29, 37.

reinstated the hammer check and also used an improved escapement action – one that had an individual escapement for each key. Effectually, these instruments were like louder versions of a clavichord. Of course the tangents were replaced with hammers and a nut was added in the back of the instrument to determine the speaking length of the string, but other than that these instruments varied little with the clavichord of the time. The young Mozart, however, was enthusiastic about Stein's pianos, and in a letter to his father in October of 1777,[22] he wrote:

> I can attack the keys any way I want, the tone will always will be even….His instruments have this distinguishing feature: they are made with an escapement. Not a man in a hundred bothers with this; but without an escapement it is impossible for a pianoforte not to block or leave an aftersound.

In February of 1771, Americus Backers, working in London, invented a new forte-piano, which is arguably the direct ancestor of the modern piano. Unlike Cristofori, Backers did not use an intermediate lever to act on the hammer; instead, the jack worked directly on the hammer. The escapement was regulated by an off-set screw under the hammer rail, which could be simply adjusted by the owner of the instrument. Backers' instruments included a true 'back check,' quite good repetition, and two pedals – the one on the left acting as the *una corda* and the one on the right acting as the sustaining pedal, generally raising all the dampers both in the treble and the bass.

In England, at the turn of the century, John Broadwood worked to enhance the piano's capabilities. He experimented with the hammers' striking point, finally settling on between 1/9 and 1/10 of the speaking length, a point which increased the partials and tone of the instrument. Also, he divided the bridge into two sections, separating brass

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[21] Loesser, *Men, Women*, 39.
[22] Loesser, *Men, Women*, 100.

strings in the bass from steel strings in the tenor and stretching each metal to its optimum tension.

Expansion and durability were the trends of the early 19th century. The weight of the hammers was increased,[23] which demanded heavier strings at increased tension. The increased tension in turn called for more durable casing. Little by little, builders moved in the direction of the full cast-iron frame. Also, the keyboard was being lengthened – it was increased from a little over five octaves to seven octaves, and later to seven and one-third octaves.

Sebastian Érard and his son Pierre made the next most significant contribution to pianoforte technology. They took out numerous patents on the subject and dominated the industry for quite some time. In 1808, they developed the *méchanisme à étrier*, in which an intermediate lever was re-introduced to place downward action on the rear piece of the hammer butt. In their design, the mechanism quickly re-catches the hammer so that notes can be repeated easily even with the smallest movement of the key. The Érards took out patents again in 1821 and 1835 with only slight modifications to their original model. In 1851, the Érard piano won the most prestigious award at London's Great Exhibition.

Two years later, Steinway and Sons was established in New York. In 1859, Steinway took out a patent for over-stringing, which utterly transformed the sound of the piano. Over-stringing allowed for the bass strings to be strung diagonally directly above the treble strings, thus not only allowing longer bass strings (and thus better tone quality) within the same size case, but also, because of the new proximity of the bass and treble strings, producing a whole new world of sympathetic vibrations for every vibrating string. After this point the Steinway Company swiftly rose to pre-eminence as the leader

[23] In 1800, it took 34 grams to sound c"; in 1860, this had increased to around 80 grams.

in the industry. Theodore Steinway patented the metal action frame to prevent warping of the action over time; the duplex scale,[24] which provided proportioned lengths of speaking length to enhance the tone of the piano; and the laminated case, which was stiffer and more durable and was also said to improve tone. Theodore's brother, Albert, patented the *sostenuto* pedal a few years later in 1874. Although this pedal had been introduced in France as early as 1844 by Jean Louis Boisselot and was modified by Claude Montal for a display at the 1862 London International Exhibition, the modern *sostenuto* pedal owes much to Steinway's patent.

Slowly other manufacturers caught up, and after 1915 certain items became almost universally standard, such as the Érard action, over-stringing, three pedals, felt hammers and dampers, wooden actions, cast-iron frames, spruce soundboards and a keyboard of seven and one-third octaves. In the 1930's Steinway introduced a new duplex scale,[25] the diaphragmatic soundboard, and the revolutionary accelerated action. The diaphragmatic soundboard was designed to taper slightly from the center to the edges to assure freer and more unified vibrations. In the accelerated action, each key pivots on a rounded bearing rather than a flat one. This new action became recognized as one of

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[24] The duplex scale can be defined as the part of the strings on each side of the vibrating portion. The purpose of duplex scale is that this non-speaking length of the string, located between the bridge pin and the hitch pin, resonates sympathetically with the vibrating portion, adding a new world of overtones to the sound. Steinway's duplex scale was anticipated about fifty years earlier by an experiment conducted by the German piano builder Wilhelm Leberecht Petzoldt. In this experiment, Petzoldt put a small bridge behind the normal one with the intention of exploring the possible additional resonance of the sympathetic vibrations in these short lengths of string. Previously, these short lengths were considered waste ends and were dampened with cloth.

[25] Steinway's earliest use of the duplex scale included aliquots, which are individually positionable contact points. Because they were individually positionable, they were also individually tunable. It was discovered that each note of the duplex scale should ideally have a perfect intervallic relationship with its corresponding speaking length. However, because it was so difficult to correctly position each aliquot, the Steinway company did away with aliquots and replaced them with continuous cast metal bars, a change which they thought would create generally the same effect. (Incidentally, Mason & Hamlin have used Steinway's original idea, since tuning the short stretches of string individually provides more accuracy. More recently, Fazioli has modified the whole idea by creating a stainless-steel track on which aliquots slide, improving the ease with which aliquots can be adjusted.)

the most responsive actions because it allowed for repetition of a key immediately after its original depression. Later, in the sixties, other innovations were made, such as the hexagrip pinblock, which insured more precise and longer-lasting tuning. The Italian manufacturer Fazioli has also made significant advancements in piano manufacturing. One example is their invention of a fourth pedal. This mechanism of this new pedal actually moves the keyboard closer to the strings, which not only reduces the depth of the keys by about three millimeters, but also moves the hammers closer to the strings. Because of the reduced key depth, the company claims that fast passages and *glissandi* are greatly facilitated with the use of this pedal. Also the use of this pedal allows the player to play *pianissimo* without the change of timbre that results with use of the *una corda*. Innovations in piano technology continue to be made even to this day, but the foundation of the modern instrument was clearly laid in the nineteenth century.[26]

[26] It is important to note that the instruments that Otto Ortmann used in his laboratory experiments would have been remarkably similar to those that we have today.

Chapter 4: Piano Pedagogy

In order to understand how Ortmann fits in and yet, at the same time, so strikingly stands out in a timeline of piano pedagogy, it is important to trace the history of piano pedagogy itself and examine the pedagogical trends and ideological pendulum swings that took place throughout. Before delving into Ortmann's research, we must place him in a historical perspective.

Trends in piano pedagogy began with what came to be known as the finger school of piano playing, likely due to the influence of performing techniques from the piano's predecessors, the harpsichord and clavichord. The two treatises of Muzio Clementi, *Introduction to the Art of Playing the Pianoforte* and *Gradus ad Parnassum*, along with a similar treatise by his student Johann Baptiste Cramer,[27] are perhaps the first significant treatises on piano playing that embody this line of thought. Descriptions of tone production at the piano, while minimal and cursory, incorporate words such as "strike" or "blow" to indicate contact with the key, and they caution against excessive arm movements. Thus, if taken at face value, it seems that these treatises promote a relatively fixed position at the keyboard in which all sound is produced exclusively by the fingers.

Johann Nepomuk Hummel, who in fact studied with Clementi for a time, wrote a similar treatise two decades later. His *Complete and Theoretical Practical Course of Instruction on the Art of Playing the Pianoforte*[28] includes over two-thousand exercises along with a charming list: "chief qualities that a good master should possess." Although

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[27] Cramer's treatise is known in English as *Instructions for the Pianoforte in which the first Rudiments of Music are clearly explained and the principal rules on the art of Fingering, illustrated with numerous and appropriate Exercises to which are added lessons in principle major and minor keys with a Prelude to each key*, 4th ed., London: S. Chapell, n.d.

[28] Hummel, *Ausfürlich theoretische-practische Anweisung zum Piano-forte Spiel,* (Vienna, 1828).

less than a century later this treatise was often seen as a product of misguided thinking, there are many useful elements of the book even for modern-day piano students.

Ludwig van Beethoven never qualified his ideas on piano technique by writing his own method book, but there is some suggestion that he was unhappy with the existing treatises on piano playing.[29] Perhaps the best indication of pedagogical thought during the time of Beethoven comes from a work of Beethoven's student, Carl Czerny. Of all the available sources, Czerny's *Pianoforte School* [30] is perhaps the most closely related to Beethoven's own school of thought. It is a monumental work, but like its predecessors, the comments on any reasonable physical approach to the keyboard are kept to a minimum. While some have seen the treatise as belonging to the end of the finger-school era, certain obscure comments can be interpreted as looking forward to the coming arm-weight school of piano playing. Since Czerny studied with Beethoven, this latter notion is supported by the numerous recollections of Beethoven's style of playing and the fact that he seemed to insist that the fingers should be complemented by the use of the upper arm.[31]

When Frederic Chopin arrived in Paris in the 1830's, the most influential pianist of the day was Freidrich Kalkbrenner. Although his fame would soon be overshadowed by the likes of Franz Liszt and Sigmund Thalberg, Kalkbrenner enjoyed a time of widespread influence. In 1830, he published his own treatise on piano playing. In his *Méthode*, Kalkbrenner attempted to promote his invention, the *Hand Guide*, which was essentially a brass bar that ran along parallel above the keyboard in order to guide the

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[29] Schindler references his saying, "I wanted to write a textbook for piano students myself, but I never had the time. I would have written something very different." *Beethoven as I Knew Him*, ed. Donald W. MacArdle, trans. Constance S. Jolly, (Chapel Hill, N.C.: The University of North Carolina Press, 1966).
[30] Czerny, *Complete Theoretical and Practical Piano Forte School*. 3 vols. (London: R. Cocks & Co., 1839).
[31] Reginald Gerig, *Famous Pianists and Their Technique*, (New York: Robert B. Luce, 1974), 91.

wrist and keep it at a fixed height. The *Hand Guide* was actually just a simplification of the earlier *Chiroplast*, a complex mechanism designed to aid in the proper instruction of the Viennese finger technique at the piano. The machine was invented by Johann Bernhard Logier in 1814, and descriptions of the *Chiroplast* sound bizarre to the modern reader:

> This then is the object accomplished by the Position frame, which consists of two parallel rails, extending from one extremity of the keys to the other; to the ends of these are fixed two cheek pieces, which by means of a brass rod and extending screw, are attached firmly to the instrument….
>
> The rails must be adjusted by means of the screws which will be found in the cheek pieces for that purpose, so as to admit the hands of the pupil passing between them nearly as far as the wrists; being so regulated as to prevent any perpendicular motion of the hand, though sufficiently wide to allow a free horizontal movement when required.
>
> By this contrivance the learned is obliged to keep himself in a proper position…By this part of the apparatus likewise the fingers are compelled to move independently…
>
> The Finger-guides are two moveable brass plates with five divisions, through which the thumb and four fingers are introduced. These divisions correspond perpendicularly with the keys of the instrument, and may be moved to any situation by means of the brass rod, on which they are made to slide. They are secured in the position required by two screws, which pass through them and press against the bracing bar.
>
> To each Finger-guide will be found attached a brass wire, with its regulator, called the Wrist-guide, the use of which is to preserve the proper position of the wrist…[32]

Ironically Czerny, who is often associated with the finger-school, criticized such devices as "useless" and complained that they "fetter[ed]…freedom of movement."[33] However, both the *Chiroplast* and the *Hand Guide* were praised by many, indicating how widely accepted and exaggerated this finger-school had become among pedagogues of the time.

Although drastic changes in the technical approach to piano technique were evident in the playing of Franz Liszt and his disciples, it was not until the second half of

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[32] From Logier's *An Explanation and Description of the Royal Patent Chiroplast or Hand-Director*, 1816. Cited in Gerig, *Famous Pianists*, 125 - 126.

[33] Gerig, *Famous Pianists*, 129.

the century that the idea of arm-weight began to take hold in formalized treatises. Some of the first pedagogues to actively advocate the use of the upper arm in their teaching were Ludwig Deppe and Adolph Kullak, students of Adolph Marx, who himself had already promoted the use of weight to project melodic lines. Kullak was the author of several books on piano playing – *The Art of Touch* (1855), *The Musically Beautiful* (1858), and *The Aesthetics of Piano Playing* (1860) – and was a firm believer in the activation of the upper arm:

> The lifting of the fingers is done with the help of the hand, and when more intense expression is required then even the help of the whole arm is brought into play.[34]

Although he wrote much less than Kullak, Ludwig Deppe's approach is also specifically recorded. Deppe bitterly complained about the terrible training of piano students and on several occasions stated that he planned to write several volumes on piano technique. Unfortunately, he died before he his material was formalized or published. However, he appears frequently in Amy Fay's *Music Study in Germany*,[35] and his teaching methods are carefully laid out in Elizabeth Caland's *Artistic Piano Playing as Taught by Ludwig Deppe*.[36] In many ways, Deppe was remarkably ahead of his time. He strongly believed in the use of the arm and back muscles to control arm weight and produce a good sound at the piano. He also insisted on fine legato, sensitivity of touch, and intelligent forms of practicing.

About this same time, Theodore Leschetizky began to teach and shape pianists in Russia. Although in his younger years Leschetizky studied with Czerny in Vienna, he

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[34] From Kullak's *The Art of Touch*. Cited in Gerig, *Famous Pianists*, 248.

[35] Amy Fay, *Music-Study*, (New York: MacMillan Company, 1896).

[36] Caland, *Die Deppesche Lehre des Kalvierspiels,*1893, trans. Evelyn Sutherland Stevenson. (Nashville: The Olympian Publishing Co., 1903).

soon sought something more from piano playing than the dazzling finger-school playing he heard there. Around 1850, he heard Julius Schulhoff, who had been a close friend of Chopin, and he describes the first time his ears became open to something new:

> Under his hands the piano seemed like another instrument. Seated in a corner, my heart overflowed with indescribable emotions as I listened. Not a note escaped me. I began to foresee a new style of playing. That melody standing out in bold relief, that wonderful sonority – all this must be due to a new and entirely different touch. [37]

He became obsessed with what he called a "singing tone" at the piano and began to develop his own ideas about piano technique. His influence is not to be underestimated as he taught some of the foremost pianists of the subsequent generation, Paderewski, Schnabel, Friedman and Moiseiwitsch, to name a few.

In an utter reaction against any remnants of the finger-school, the idea of the free arm was taken to the extreme at the turn of the century, especially by Rudolph Breithaupt, the author of *Natural Piano Technic* [38] and *School of Weight-Touch*.[39] In his books, Breithaupt categorically dismisses any form of movement at the keyboard which does not incorporate the arm as well. He continually stresses the absolute necessity of arm-weight and uses such phrases such as the "swinging arm," "absolute relaxation," and "play with weight touch." Breithaupt's theories are, in many ways, the opposite side of the pendulum swing from pure finger technique. Unfortunately, like many others who came before, his writing suffers from vague, contradicting descriptions and, often, scientifically unsound statements. Breithaupt does include some cursory mention of finger action in piano playing:

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[37] Angèle Potocka, *Theodore Leschetizky, An Intimate Study of the Man and the Musician*, trans. Genevieve Seymour Lincoln, (New York: The Century Co., 1903), 89.
[38] Breithaupt, *Die Natürliche Klaviertechnik*, 2 vols, (Leipzig: C.F. Kahnt Nachfolger, 1905).
[39] Breithaupt, *Die Grundlagen der Klaviertechnik,* trans. John Bernhoff, (Leipzig: C.F. Kahnt Nachfolger, 1905).

> He that commands a loose arm and can "*play with weight touch*," may use the fingers whenever he feels they are required.[40]

He also gives similarly brief mention of other elements of piano playing, for example a state that he calls "fixation," or a midway point between relaxation and rigidity.[41] While there is much truth in both volumes of Breithaupt's work, the fact that he underplays the role of finger articulation often led to unrefined, clumsy playing in his followers. Maria Levinskaya, who was an important pedagogue in her own right, recalls that even Breithaupt's own playing suffered from lack of clarity:

> I came to Berlin with the intention of finding a music teacher for "finishing lessons." I paid a visit, among others, to Mr. Breithaupt, who at our first interview whilst developing his theories, approached the piano and showed a few passages…on hearing his version of correct playing it was so far removed from my own ideal that at once I decided to study with Godowsky. It is only now, in the light of my analysis of Breithaupt's theories in print, that I can fully understand why such an impression was inevitable, for in playing he evidently tried to follow his own precepts, and avoid all precise finger articulation.[42]

One cannot catalogue the history of piano pedagogy without including the name of Tobias Matthay. Although other English men, such as William Townsend or Harold Bauer, preceded him in writing about piano playing, Matthay's work is arguably the most comprehensive and influential. His book *The Act of Touch in All Its Diversity*,[43] published one year before Breithaupt's *Natural Piano Technic*, is divided into four sections. The first deals with general aspects of piano playing, the second and third with key treatment from the instrumental and muscular aspects, respectively, and the fourth with position. After its publication, the book was soundly criticized for being hard to read:

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[40] Breithaupt, *Natural Piano Technic*, 56.

[41] Gerig complains that Breithaupt would only allow already extremely accomplished pianists to use anything other than arm weight in their pianistic arsenal. *Famous Pianists*, 356.

[42] Maria Levinskaya, *The Levinskaya System of Pianoforte Technique and Tone-Colour through Mental and Muscular Control*, (London: J.M. Dent and Sons, Ltd., 1930), 56.

> Of economy, either in time, words, paper or printing ink, Mr. Matthay has no conception…The result is so bewildering…Of course there is much more in the book, and many things have pedagogical value; but it is laborious to dig them out of Professor Matthay's verbal tumulus.[44]

In spite of his obtuse writing style, Matthay's intense curiosity and dedication to find the truth in piano playing still shine through on each and every page. Like Breithaupt, Matthay promoted arm weight to support finger action, though he did not take it quite to such an extreme. In 1934 he even railed against Breithaupt's precepts in his last major work, *The Visible and the Invisible in Pianoforte Technique.*

Although Matthay's books cannot be viewed as scientific works, it was perhaps his intellectual inquisitiveness that paved the way for the wave of methods that came afterwards, for it was around this time that many methods appeared claiming to be purely scientific approaches to piano playing. James Ching and Thomas Fielden both considered their research to be of this scientific nature.

James Ching, even though he was partly trained by Matthay, ardently disagreed with him, especially on the subject of weight playing. He blamed a condition which he called "pianist's cramp" on weight playing and recalls that Matthay was unable to relieve him of it. In fact, he strove to "eliminate the whole concept of weight from the theory of piano technique" and called it a "millstone" to pianists.[45] Due to this violent and seemingly outlandish reaction against the instruction of Matthay, it seems clear that he misunderstood Matthay's generally well-balanced ideas on the use of upper arm weight for a sort of active pressure into the keys, which easily could have caused an injury like the one he describes. However, Ching gave many lectures and was the author of several books on the subject, and because he had worked with university professors specializing

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43 Matthay, *Act of Touch*, 1903. (London: Bosworth and Co., 1963).

in physiology, he claimed to have formulated the first truly scientific method with his book *Piano Technique: Foundation Principles*.[46]

A few years earlier, in 1927, Thomas Fielden published *The Science of Pianoforte Technique.*[47] Fielden actually worked at the Royal Academy of Music alongside Matthay, but he was extremely critical of his colleague's writings and essentially grouped Matthay's deficiencies along with those of Breithaupt:

> It is necessary to point out that neither of those men, Matthay less than Breithaupt, sufficiently emphasized the necessity for scientific knowledge of physiology, and the relations and coordinations of the muscular actions; nor did they insist enough on a knowledge of the laws of mechanics…[48]

His book includes a lengthy analytical section on arm and finger movements and another large portion devoted to leverage as related to tone production. He also includes some physical exercises to strengthen the muscles used in piano playing. While the work was generally well received, it is perhaps not as scientific as it claimed to be, as George Woodhouse points out in his review of the book.[49] In addition, Fielden overlooked the valuable research of another pianist-scientist, who was working around the same time, Otto Rudolph Ortmann.

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[44] From a review of Matthay's *Act of Touch*. First appeared in the *New York Tribune*, September 28, 1904. Gerig, *Famous Pianists*, 371.
[45] Ibid., 403.
[46] James Ching, *Piano Technique*, (London: Chapell, 1934).
[47] Thomas Fielden, *Science of Pianoforte Technique.* (London: MacMillan and Co. Ltd., 1927).
[48] Ibid., 10.
[49] George Woodhouse, "Common Sense at the Keyboard," *Music and Letters* 9, no. 2 (1928): 140-144.

PART THREE: OTTO RUDOLPH ORTMANN

Chapter 5: Life

Otto Rudolph Ortmann was born in 1889 in Baltimore, Maryland to parents who were both musicians.[50] Ortmann began his university studies at Baltimore City College and later continued at Johns Hopkins University. He furthered his education by studying at Peabody Conservatory, from which he received an artist diploma in composition in 1917. While at Peabody, he studied piano with Ludwig Breitner, George Boyle, and Max Landow, all of whom were concert pianists trained outside the United States.[51]

After graduating from Peabody, he was appointed to the faculty as a teacher of piano and harmony. He held this post until 1928, at which point he was named director of the conservatory. He held this post for over twelve years, and under his watch, the standards of the conservatory were raised significantly. From 1942 to 1957 he taught at Goucher College, where he served as head of the Music Department. After 1957 he taught privately from his home, and in the late sixties, he received the Peabody Conservatory Alumni Association Award. He died in 1979 at the age of ninety.

During his long life, he wrote on many subjects about music, including music education and music appreciation, and he published two books on piano playing: *The Physical Basis of Piano Touch and Tone*[52] and the *Physiological Mechanics of Piano Technique*.[53] In addition, he wrote many articles for prestigious journals such as *Journal of Comparitive Psychology* and the *Musical Quarterly*. Those especially relevant to this

[50]Although little is known about his father's involvement with music, his mother was at one time offered a contract with the Metropolitan Opera.
[51] Gerig notes that Boyle had been a student of Busoni. *Famous Pianists*, 411.
[52] Ortmann, *Piano Touch and Tone*, (New York: E.P. Dutton, 1925).
[53] Ortmann, *Physiological Mechanics,* 1929, (New York: E.P. Dutton, 1962).

treatise include “What is Tone Quality?”[54] and “Tonal Intensity as an Aesthetic Determinant,”[55] both of which were published in the *Musical Quarterly*. He also translated Paul Hindemith’s *Unterweisung Im Tonsatz* [56] at Hindemith’s own request.

54 Ortmann,“Tonal Intensity as an Aesthetic Determinant,” *Musical Quarterly* 14 (1928):178-191.
55 Ortmann, “What is Tone Quality?”, *Musical Quarterly* 21 (1935): 442-450.
56 Paul Hindemith, *Unterweisung im Tonsatz*. Mainz: B. Schott’s Söhne, 1937.

Chapter 6: Description of Works

Ortmann's works are debatably the first comprehensively scientific works on piano playing. What is clear is that he broke with the subjective approach of his predecessors and introduced a whole new way of addressing the topic. His writing is generally rather dry and objective, and he approaches the problems of piano playing as a scientist – by first asking questions and then conducting experiments to find the answers. Unlike many of his predecessors, he was not adhering to any overarching methodology and did not hope to prove any particular biased opinions. As one might imagine, he opened himself to much criticism. He was accused of being impersonal and cold, extracting any human element or mystery from piano playing. Those in opposition to his work argued that piano playing was an art and could never be reduced to a science. On the contrary, Ortmann the musician-scientist felt that art and science could and should work hand-in-hand.

His first book, *The Physical Basis of Piano Touch and Tone*, was written in 1925 while Ortmann was still on the faculty of Peabody. After a performance by Harold Bauer of Schumann's *Kinderszenen*, Ortmann was asked, "Do you mean to tell me that such poetic effects are produced by means of mere variation in key speed and time duration?" This question, which Ortmann deemed "so often asked and so variously answered," prompted the investigation.[57] The book, slightly under two-hundred pages, is a compilation of Ortmann's findings as a result of his various studies and experiments in laboratory of Peabody Conservatory. The book addresses the fundamental problem of piano touch and tone – it attempts to separate what pianists actually hear or do at the piano versus what they imagine they hear and do. In the opening chapters, Ortmann is clear in limiting the scope of the problem to the production of a single tone. In other words, he eliminates from his investigation what happens before the finger touches the key and what happens when the sound wave hits the ear. The object of the book was to determine scientifically whether or not all effects in piano playing come from variations in intensity and duration of tone. Although this work employs much more scientific research than any of its predecessors, Ortmann himself wished he could have been even more precise in his experiments. In fact, he prefaces his book by saying that "the scope of the work and the method of procedure adopted in it were far from being as complete and accurate as I would have liked them to be."[58] Later in his life, in 1967, he stated that he wished that he had had the equipment available "at that time…which is now at hand," commenting that it would have saved many hours of work and frustration.[59] The book consists of two parts of five chapters each, each with its own area of focus.

The first chapter deals with the mechanics of the instrument. His description is similar to what is found in the second chapter of this treatise, although organized in a different manner and perhaps slightly more difficult to follow due to Ortmann's often abstruse writing style.

Ortmann's second chapter contains an analysis of key depression. In this chapter, he distinguishes between two types of touch: percussive and non-percussive. He defines a percussive touch as one in which the finger strikes the surface of the key. In contrast, in a non-percussive touch, the finger would be in contact with the surface of the key before its descent. He also differentiates between curved and straight fingers and between high and low wrist positions. Ortmann scientifically records his findings of these various forms of touch and their combinations (See Fig. 7), and from the results, he concludes

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[57] From the preface of *Piano Touch and Tone*, v.

that all differences in touch are the result of differences in key speed. In addition, the tendencies of his findings show that curved fingers, percussive touch, and rigid arms produce louder tones than flat fingers, non-percussive touch, and relaxed arms. Two other interesting conclusions he draws in this chapter are that non-percussive touch allows for better key control and that a completely relaxed arm cannot produce a *fortissississimo* sound. In other words, some amount of rigidity in the arm is necessary to achieve extreme dynamic range.

In the third chapter, Ortmann attempts to approximate numerical values for the force of touch. He points out that while key resistance in a normal piano varies slightly from bass to treble, these variations are relatively insignificant in their musical effect. From experimentation he concludes that tonal effect on the piano is most efficient when secured by a vertical non-percussive descent near the outer edge of the key. In this chapter Ortmann states that he is not concerned whether these findings have any practical value for piano pedagogy; they are just facts for pianists to consider. At the same time he justifies the investigation:

> In attempting to reconcile the conflicting opinions held on the question of the personal element in piano playing, nothing is too small to be omitted.[60]

The fourth chapter is devoted to touch combinations, namely simultaneous or successive key depressions. Ortmann asserts that in simultaneous key depression only key-speed can be altered, and in successive key depression only key-speed and the time interval between tones can be altered. He does not focus on *legato* or *staccato* touches, but rather on musical terms that are more difficult to localize, such as *affettuoso* or

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[58] From the preface of *Piano Touch and Tone,* v.
[59] Gerig, *Famous Pianists*, 412.
[60] *Piano Touch and Tone*, 49.

giocoso.[61] The findings of his experiment coincide with the former assertion that all artistic effects in sound, including the "most poetic effects," are secured on the piano by variation in key-speed and in time interval between key release and key depression. Again in this chapter, Ortmann comments that to what extent a teacher should direct the matter of key-speed to pupils is exclusively a "pedagogical problem."

The next chapter, the final chapter of Part I, focuses on the theoretical analysis of hammer stroke. Ortmann notes that there is but one action of the hammer against the string – namely a sharp, percussive action. He points out that in no case is it possible to increase the hammer speed after escapement and that for every increase in hammer speed, there is an increase in string displacement. Again, in this chapter he concludes that all differences in hammer speeds are differences in intensity.

The second part of the book begins with analysis of string and sounding board vibrations in Chapters 6 and 7. Ortmann includes some discussion of acoustics and records the findings of his experiments on touch effects on the vibration of the strings and soundboard.

Although up until Chapter 8 the scope of the book has been limited to the production of a single tone, Chapter 8 is a discussion of tone combinations. Ortmann grants that when two tones overlap, there is an "inexhaustible field of colour" available. He still asserts, however, that all combinations are simply the result of varying pitch, intensity, and duration. He does concede that use of pedal increases tonal possibilities and variations. Use of the damper pedal increases tonal possibilities because of the "sympathetic" vibrations of all the other strings when dampers are raised, and use of the

[61] These Italian terms are often used by composers as indications of the manner of playing. *Legato* (literally, "tied together") indicates to play smoothly and connected. This form of touch will be discussed in more depth later in this treatise. *Staccato* ("detached"), the opposite of *legato*, specifies to play the notes

una corda gives tone color a slightly "veiled" quality due to the difference in elasticity of that less frequently used part of the hammer. Ortmann also notes some aspects that are outside the player's control, such as the acoustical phenomena known as beats.[62]

Particularly interesting is Chapter 9, a discussion of the noise elements in piano playing. Ortmann discusses all varieties of noise included in piano playing: the impact of the finger on the key, the impact of the hammer against the string, the impact of the key against the key bed, and the various friction noises of the action. Ortmann maintains that while the average listener or pianist is usually unaware of the noise elements in piano playing, these differences affect tone quality in a variety of ways. While the differences may be minute, the ear is a fine-tuned instrument that should be able to distinguish these relatively small differences in tone quality.

The final chapter deals with the propagation of sound, in other words, the traveling of the waves from the moment they leave the instrument to the point where they reach the listener's ear. Ortmann mentions four phenomena that affect sound propagation: diffusion, reflection, interference, and resonance. He defines these phenomena, evaluates their effect on piano tone, and concludes that many tonal effects are due to these acoustical phenomena and are not under a pianist's control. It is here he suggests that instead of looking for a "good" tone, a pianist should search for the most "suitable" tone:

> Moreover, a really "good" tone would include the absence of all noise elements…because this ideal is never really reached in practice, many authors and teachers maintain that we should demand of the pupil, not the production of a good tone, but the production of a suitable tone. The pupil

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in a short, disconnected way. *Affetuoso* and *giocoso* are character indications. *Affetuoso* means to play a passage with feeling or passion, and g*iocoso* means "playful."

[62] When two waves flow past a place at the same time and there is a difference in wave length or frequency in the two waves, an interference called beats will occur. The number of beats per second is equal to the difference of the two frequencies that are causing the beats.

> should ask: is it adapted to the particular passage? Does it harmonize with its tonal environment? Certainly…this viewpoint is to be preferred.[63]

Ortmann closes the book with a two-page summary of the preceding chapters, in which he declares that "what we actually do, then, when playing the piano, is to produce sounds of various pitch, intensity, and duration." He goes on to say that "what we imagine we do and hear is a different question, the answer to which awaits the outcome of an experimental investigation of the physiological and the psychological aspects of the problem."[64] This comment indicates that Ortmann was planning on writing two other books to complete his "trilogy" – one on the physical elements of piano playing and another on the mental aspects. Unfortunately, he never completed the latter.

His second book, *The Physiological Mechanics of Piano Technique*, was his solution to the first part of the problem. This book, an extensive study spanning over three-hundred seventy-five pages, is broken into three major parts, "The Physiological Organism," "General Aspects of Physiological Movement," and "The Touch Forms of Piano Technique." He opens the first section by setting forth certain scientific principles that apply to piano playing and follows with detailed discussions of the skeletal, muscular, neural, and circulatory systems.

The second part of the book deals with physical approach to the keyboard. Ortmann analyses such opposites as action and reaction, coordination and incoordination, as well as including sections on relaxation, weight transfer, and vertical and horizontal arm movements. Many of his conclusions in these first two parts would have been welcome to pedagogues of the time, such as his insistence that there is no substitute for repetition in piano practice due to the connections between the muscular and neural

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63 *Piano Touch and Tone*, 168.
64 *Piano Touch and Tone*, 171.

systems. Other assertions would have sent shock waves through the pedagogical world, for instance, his realization that some amount of tension or contraction is necessary in piano playing or that complete relaxation is physiologically impossible for a healthy muscular system.

The third part deals with touch forms of piano playing, including arm-legato, tremolo, and staccato. Ortmann also analyzes different manners of finger stroke in detail, includes chapters on scale and arpeggio playing, and then he closes with a section on individual differences among pianists' arms and hands and one on matters of style. In the final two pages of the book, Ortmann astutely sums up the benefits of his work. He acknowledges that he fits somewhere between the old finger-school and the opposite extreme, the relaxed weight playing of pedagogues like Breithaupt:

> Relaxation and weight-transfer are the result of an attempt to get away from the fixed hand position technique…As is so often the case, the pioneers in the movement, in applying a helpful means, went to the other extreme, which their less capable disciples slavishly followed. In the foregoing pages is sufficient evidence to show the need for a partial return to the older school: the need for practicing finger drill…I feel quite sure that in the last decade, finger stroke has not received adequate consideration in piano pedagogy, and that undue stress[65] of relaxation has seriously restricted velocity and technical brilliance.[66]

In this same section, he again stresses the importance of the psychological aspect of piano playing and argues that the knowledge recorded in his book is of great value to a pianist or piano teacher. He closes by asking a series of new questions about such subjects as memory, performance anxiety, imagination in piano playing, and desirable practice methods. In fact, the list sounds almost like the introduction to a new book, one that would deal with the psychological and emotional aspects of piano playing – one he clearly was planning but never completed.

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[65] To clarify this seemingly strange word choice, it is important to note that the phrase "undue stress" does not refer here to a physical condition; instead Ortmann is using these words to mean "too much emphasis."

The two articles on tone that Ortmann wrote for *The Musical Quarterly* are not as specific to the piano as an instrument, but deal with tone quality as a more abstract idea. The first, "Tonal Intensity as an Aesthetic Determinant," explains the reaction within the human ear to weak, almost inaudible sounds and to intense sounds that cause pain to the eardrum. This reaction can be easily explained physiologically, and Ortmann argues that it should not be forgotten when considering reactions to music. He goes into detail discussing harmonic dissonance combined with varying tonal intensity, arguing that one's emotional reaction to certain chords is interconnected to the physiological reaction within the inner ear. The second article, "What is Tone Quality?," deals with the elusive question of its own title. Ortmann defines tone quality as "a subjective reaction...our unified reaction to the three variants of pitch, intensity, and duration."[67] By calling tone quality the "psychological resultant" of those three elements, he infers that any change in any one of the three results in a change in tone quality. In the article, he makes use of several recorded findings on the oscillograph to demonstrate his theory.[68]

[66] Ortmann, *Physiological Mechanics*, 376.

[67] Ortmann,"What Is Tone Quality?," 448.

[68] An oscillograph can simply be defined as any device that records oscillations. Ortmann used an electrical oscillograph to record soundwaves.

Chapter 7: Reactions to Ortmann

Reactions to Ortmann's writings were mixed. As previously mentioned, his new approach and his complex but aloof style of writing drew much attention – criticism as well as praise. After his first book was published, a review in *The Musical Times* presented conflicting feelings about the work. The article begins almost tongue-in-cheek:

> This is the sort of book that should please everybody – both those who play and those who listen. What, for instance, could be more encouraging for Miss Cicely Blank, who is looking forward to giving her first recital at Wigmore Hall in the coming season, than to be told that her interpretation of Chopin's fourth Ballade differs from Paderewski's only in mere variations of key-speed and time-duration? Yet she may gather such from the first words of the preface of Otto Ortmann's coldly precise and scientific work, which he has given to the world as the fruit of continued experiment in the laboratory of the Peabody Conservatory of Music. And what could be more encouraging to those whose ears have suffered from the grossness of tone which characterizes so much modern pianoforte playing than to see some attempt made to explain it on a physical basis?[69]

Although he does call it "cold" and "scientific," he goes on to praise Ortmann's work for being thorough and well organized, and concludes by boldly stating that "it would be an ungrateful man who would quarrel with him on the larger side of the claims that [Ortmann] makes." He admonishes every pianist that he has a lot to learn from the book and concludes that each pianist should be able to improve his tone if Ortmann's research is properly understood and applied. Four years later, another review covered Ortmann's *Physiological Mechanics.*[70] In many ways, this review is more negative, because although the author does not dispute the veracity or value of Ortmann's findings, he calls the scientific experiments the "least satisfying" element of the book and accuses Ortmann of taking too lightly the difficulties involved in a scientific treatment of the subject of piano playing. He directs the pianist to ignore the scientific descriptions and pay

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[69] Paul Kegan, Review of *Piano Touch and Tone*, *The Musical Times*, 66, no. 987 (1925): 421-422.

attention to only the purely practical advice that Ortmann provides. Ironically, this reviewer seems to think that Ortmann's conclusions can be valuable even if the methods by which he arrived at those conclusions are fundamentally flawed. The reviewer criticizes Ortmann for not citing the well-known work of Tobias Matthay or the work of W. MacDonald Smith.[71] Ortmann may have agreed that perhaps his science would "not satisfy a scientist" in all counts. In fact, as seen before, he himself wished he could be more precise. However, he would arguably feel that by completely nullifying the validity of his scientific experiments, one also invalidates the conclusions. In fact, the whole motivation for his research was his frustration with the subjectivity that often went along with piano playing:

> I became aware of the marked difference between my own technical achievements and those of well known concert pianists. This, in turn, led to an investigation of the whys and wherefores of individual technical variations. The explanations given me were so often the subjective expression of the player himself that the underlying physiological facts were unintelligible, nor was there agreement among the pupils even of any one teacher. This subjective approach indicated, in my mind, the need for an objective experimental investigation. And thus began the laboratory work.[72]

Ortmann was most likely familiar with both the work of Matthay and Smith. In fact, in a letter to Reginald Gerig in 1967, he mentioned having "read Matthay's books carefully."[73] In fact, he lists Matthay's works in his lengthy bibliography. He was also familiar with the work of the German pianist and scholar Eugen Tetzel, who in his book

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[70] Paul Kegan, Review of *Physiological Mechanics*, *The Musical Times*, Vol. 70, No. 1042, (December 1929): 1084-1085.
[71] W. MacDonald Smith's articles, "The Physiology of Pianoforte Playing, with a Practical Application of a New Theory" and "From Brain to Keyboard" first appeared in the Proceedings of the Musical Association, the first in the 14th session in 1887-88 and the second in the 21st session in 1894-5. "From Brain to Keyboard" was later published as a small booklet (Boston 1917). Smith advocates many of the concepts that Ortmann does, such as the lateral shift of the forearm instead of the more widely accepted thumb crossing.
[72] Cited by Gerig, *Famous Pianists*, 412.
[73] Gerig, *Famous Pianists*, 411.

Das Problem der Modernen Klaviertechnik [74] was one of the first to advocate the idea that a single tone could be influenced only by its intensity. However, the point of his research was not to prove anybody else's theories or conclusions, but to start purely objectively, as a scientist would, simply with questions and a blank slate.

After Ortmann's *Physiological Mechanics* was published, those other than critics in the music world became familiar with the work, which was actually surprising considering the unfortunate circumstances surrounding the work's first publication. Given the technical and specific focus of Ortmann's research, most average amateur pianists would not have been interested in it. Thus, the audience for the book would have surely been quite limited. In addition, the book was published in the same year that the Great Depression began in the United States. Given the opulence of the book, due not only to the great length but also to the many photographs, it was quite expensive, especially for those dealing with the crippled American economy. The book became an item that only the elite could afford. To make matters more complicated, the book was published in England, and during the Second World War enemy bombings destroyed the original plates. This made a reprint of the book impossible after the first publication sold out.[75] The book was not re-released until over thirty years later with a new publication in 1962. Sadly, *Physiological Mechanics* is currently out of print again and is quite difficult to acquire. The 1929 version is almost impossible to find and copies of the 1962 version sell for two or three-hundred dollars each.

In spite of these difficult circumstances, Ortmann's research was still able to reach and influence a specific audience. In 1928, George Woodhouse reviewed Thomas Fielden's *The Science of Pianoforte Technique*. Although it is a generally positive

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[74] Eugene Tetzel, *Das Problem der Modernen Klaviertechnik*, (Leipzig, Breitkopf & Hartel, 1909).

review, Woodhouse criticizes Fielden for neglecting to include the findings of his colleague Ortmann. He writes:

> In one important particular, Mr. Fielden is behind the times in his unscientific predilection for speaking of pianoforte tone quality as if it were within the control of touch and not linked up inseparably with that of tone intensity. Mr. Ortmann has destroyed this illusion once and for all in his work *Pianoforte Tone and Touch*, but the old belief still lingers even in the minds of professed scientists.[76]

Woodhouse speaks of Ortmann as if he has proved an undeniable truth. Other writers followed in agreement. Carl Seashore, a professor at The State University of Iowa in 1937, calls Ortmann's book "the best available book on the subject" in his article for *The Scientific Monthly*.[77] Even new experiments were organized to prove or disprove Ortmann's conclusions. In 1930, William Braid White published an article for the *Journal of the Acoustical Society of America*, in which he revealed the results of experiments that had been conducted at the American Steel and Wire Company.[78] White used oscillographs to record the sound of tones produced by accomplished pianists and concluded that every time the pianist attempted to change the tone quality, the pianist also produced a change in intensity or loudness. In 1934, three professors at the Moore School of Electrical Engineering at the University of Pennsylvania – Harry Hart, Melville Fuller, and Walter Lusby – conducted a set of experiments to settle the question of whether or not the pianist has any influence on the tone quality by the way in which he strikes the key. Using a mechanical striking device and employing the services of the famous concert pianist Abram Chasins,[79] Hart, Fuller, and Lusby compared the hammer

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[75] From the Introduction by Arnold Schultz to the 1962 reprint of *Physiological Mechanics*.
[76] Woodhouse, "Common Sense at the Keyboard," 143.
[77] Carl Seashore, "Piano Touch." *The Scientific Monthly* 45, no. 4 (1937): 360-365.
[78] W.B. White, "The Human Element in Piano Tone Production," *The Journal of the Acoustical Society of America* 1 (1930): 357-365.
[79] Abram Chasins was a pianist, teacher, and composer who lived from 1903-1987. He studied piano with Godowsky, Hofmann, and Goldmark. From 1927 to 1947, he was an active performer, appearing both in

displacement and sound wave forms of tones produced consecutively by the machine, by Chasins, and by Hart, who was not a pianist. They concluded that the tone quality of a single tone can be altered only by the intensity and thus, the loudness, of the tone. Their article, which also appeared in the *Journal of the Acoustical Society of America,* continues:

> The skill of the pianist depends upon the way in which he combines tones; making certain tones stand out by dynamic emphasis and making others stand out by agogic or timing emphasis.[80]

Hart, Fuller, and Lusby conclude by recognizing that their experiments re-confirm the research of both Ortmann and White.

Arnold Schultz devoted a full chapter to the analysis of Ortmann in his book, *The Riddle of the Pianist's Finger*. Although he admits that it is not "easy reading," he asserts that the work is a "mine of accurate information."[81]

Others seemed to misinterpret the writing of Ortmann. For example, Maria Levinskaya, in a lengthy letter to the editor of the *Musical Times* claims that those with scientific "prejudices" seem to contradict themselves and promote ignorance. She proceeds to complain:

> Either the pianist's touch influences the tone of the pianoforte (and it is only thus that the most palpable difference between one pianist and another in his touch could be brought home to us) or touch cannot influence the tone…Surely the whole object of re-adjusting the pianist's touch is to obtain different tone-results from the pianoforte![82]

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solo recitals and with orchestras across the United States and abroad. He taught at the Curtis Institute for twenty years, and later in life he was the music director at the radio station WQXR (New York) from 1943 to 1965.

80 Harry Hart, Melville Fuller and Walter Lusby, "A Precision Study of Piano Touch and Tone," *Journal of the Acoustical Society of America* 6 (October 1934): 80-94.

81 Arnold Schultz, *The Riddle of the Pianist's Finger*, (Chicago: The University of Chicago Press, 1936), 310.

82 Maria Levinskaya, "The Truth about Pianoforte Touch and Tone-Colour," *The Musical Times*, (July 1, 1930): 638.

Although she does not specifically criticize Ortmann himself, she clearly does not understand the distinctions made in such research between the production of one tone and the combination of tones. In the letter, she never acknowledges any connection between what she calls "tone-colour" and the intensity of the sound. Also, in spite of her attempt to qualify her interpretation of the term "tone-colour," she is actually rather vague in her explanation. She claims her book contains "scientific analyses" of ways to control piano tone quality, but in this letter she uses an anecdote as proof of her system:

> Some friends, hearing [a pupil of mine] play congratulated her on a new pianoforte, saying that its tone was so much more beautiful, only to discover to their astonishment that it was the same pianoforte, but that the complete change was due to her newly-acquired touch, which made the pianoforte tone practically unrecognizable."

Just a few years after the Levinskaya letter, an article appeared that blatantly disparaged Ortmann.[83] Mary Cochran, Australian piano professor and author,[84] condemns his use of the words "strike," and "blow" to indicate key depression and infers from Ortmann's choice of language that he regards percussive touch on the piano as the normal piano touch. She then launches into a long defense of what she calls the 'weight' touch, or non-percussive touch, using as her proof the beautiful playing of the pianist Wilhelm Backhaus, whom she had recently heard in recital:

> Mr. Backhaus rarely used a percussive touch, and only for a special reason. One might listen to recital after recital without hearing a single unbeautiful tone.[85]

She also scorns Ortmann's use of the term "rigidity," and holds that while the joints have to be "moveless," they cannot be rigid, since in order to play a passage, joints must constantly change position. She quotes a small passage from Ortmann in which he writes

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[83] Cochran, "Facts and Fallacies in Pianism," *Australian Journal of Psychology and Philosophy* 11 (1933): 193-203.

[84] Cochran taught at the NWS State Conservatorium of Music in Sydney (now known as the Sydney Conservatorium of Music) and was author of *The Ultimate Principles of Pianoforte Teaching and Playing.*

that "rigidity is a necessary part of all loud tonal effects," and then she reacts against this statement by bringing up the fact that Backhaus never plays with this "appalling muscular condition."[86]

By taking selected sentences from Ortmann's *Physiological Mechanics* and putting them in her article completely out of context, she succeeds in making his statements seem utterly unsound. It seems that Cochran becomes extremely engrossed in nitpicking Ortmann's use of language without truly trying to understand his meaning. To one who has studied Ortmann's work, it is apparent that Cochran either did not read it in its entirety or came away with a lopsided view of his research.

After the 1930's, the discussion and debate over piano tone seemed to diminish; there were surely fewer articles and fewer experiments on the subject. However, up until the present day, writers and scholars in the field of piano playing continue to show the influence of Otto Ortmann, some agreeing with his research and some reacting against his ideas. Many of these writers will be discussed in a later chapter of this treatise. In the next chapters, we will take a closer look into the research on tone production of Otto Ortmann himself.

[85] Cochran, "Facts and Fallacies," 199.

PART FOUR: TONE PRODUCTION – ORTMANN'S RESEARCH

Chapter 8: Scientific Principles Governing the Piano

In the first chapters of this treatise, many of the scientific principles related to the piano are mentioned, especially those relating to acoustics and to the action of the piano. As has been clearly established, the piano is a machine, and is thus subject to the laws of physics. Otto Ortmann opens his research with the same premise. In fact, he begins with a list of basic scientific terms and their definitions, which he deems the "theoretical basis" of his whole book (See Fig. 8).

In the introduction, Ortmann includes explanations of some other fundamental principles, and he discusses simple physics formulae, which are important to cover. First, it is necessary to understand the difference between speed and velocity. Speed can be defined as the distance an object travels divided by the time of travel. This can be expressed in the equation $v = d/t$, where v= speed, d= distance and t= time. Velocity is similar to speed, but includes a directional quality and is thus considered a vector, or a quantity that has both direction and size. Thus, velocity can be found using the same equation: $v = d/t$, where v = velocity and d = the straight line distance or displacement. When an object starts at one speed or velocity and then begins to move more quickly, it is said to accelerate. Acceleration is the change in speed divided by the time it takes to make the change.

A general overview of Newton's laws of motion is the next step. Newton's first law is quite simple: objects at rest tend to stay at rest, and objects in motion tend to stay in motion in a straight line at a constant speed. This law describes the term inertia, which is an object's resistance to change in motion. Every object has mass, which is the

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[86] Ibid., 199.

measure of inertia. Mass is different from weight, which is a force due to the earth's gravity.[87] Newton's second law describes the relationship between force, mass and acceleration and can be realized in the equation $F= ma$, where F=force, m= mass, and a = acceleration. Newton's last law states that when an object A exerts force on another object B, object B must exert an equal and opposite force on object A.

Lastly, momentum and energy must be discussed. Momentum can be defined as the product of an object's mass and its velocity. When an object experiences a change in momentum, the result of the change is the impulse. Work is the product of total force and the displacement through which the force is used and thus can be represented by the formula: $W = Fd$. Power is the work done divided by the time taken to complete the work, or $P = W/t$. Energy is the ability to do work. An object can either have energy because of its position or it can have energy due to its motion. In physics, these two states are called potential energy and kinetic energy, respectively. Potential energy is the product of the resisting force (usually gravity) on the object and the distance the object travels. Kinetic energy, the energy an object has due to its motion, is calculated by the formula: $KE = \frac{1}{2} mv^2$. The law of conservation of energy states that energy cannot be created or destroyed, in other words, in the transfer or energy from one object to another, no energy is lost – what one object loses, the other must gain in some form.

Ortmann's descriptions of all of these scientific principles are somewhat unorganized and perhaps slightly unclear to the reader. He could have been more careful in his organization and more specific in the explanations of the formulas. For example, in one formula that he provides: $FH = C+ \frac{1}{2} mv^2$, he indicates that F stands for force and that H stands for the distance through which the body moves, but he does not include

[87] In other words, an object will have the same mass regardless of where it is in relation to earth, but weight changes depending on the object's distance from earth.

what he intends the capital C to stand for.[88] However, other than this unexplained formula, nothing else that he presents in this introductory chapter is incorrect. His explanations and formulae are similar to what one might find in an introductory physics textbook.

How does all this physics relate to the piano? Little by little, Ortmann begins to relate these scientific principles to the instrument. First, Ortmann describes the key in its function as a lever. The lever is one of the six simple machines. A lever can be defined as any a rigid object that has a pivot point. Using the lever appropriately gives mechanical advantage; in other words, it increases the mechanical force able to be transferred to another object. There are three classes of levers, each of which is shown in Figure 9.

On the piano, less than one half of the key is actually visible to the eye. In fact, the key is a long piece of wood that rotates on a fulcrum in the middle, a lever of the first class. The pin at the fulcrum prevents the key from moving sideways, and the felt pads beneath each key limit the distance which the key can move to about 3/8 of an inch. Given the boundaries set by the mechanism itself, the only possible movement of the key is 3/8 of an inch downward in a small vertical arc. This vertical arc is minimal compared to the length of the lever, so can be considered a straight line (See Fig. 10).

When the key is put into motion, it becomes a moving body and thus is subject to the laws of all moving bodies. Recalling the above information, the three properties critical to a moving body are mass, direction, and speed. It seems obvious that since the mass of any one key is fixed and the direction of the key is fixed, the only property open to variation is the speed. Using the previously explained principles, in addition to the

[88] Perhaps oversights like these fueled the criticism of the scientific nature of the book.

effect of the force, the distance through which the force acts also influences the amount of work done. But because the key allows only a small range of movement, this distance can never be more than 3/8 of an inch. Ortmann boldly asserts what he calls a "perfectly obvious fact":

> No matter how we hold our hands, how gently or harshly we stroke or strike the key, no matter how relaxed or rigid our arms are, how curved or flat our fingers, we can do nothing to the key than move it three-eighths of an inch or less vertically downward.[89]

He proceeds to apply the equation Force = mass x acceleration to the key. It is critical to note that the mass of any one key is fixed. That leaves the only conclusion that any change in force must be directly related to the acceleration of the key.[90] The production of a single tone occupies the next part of Ortmann's investigation.

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[89] *Piano Touch and Tone*, 15. This statement has been viewed with suspicion by many pedagogues, as if Ortmann were advocating that having a good technique at the keyboard was meaningless. Anyone who is familiar with his second book, which is, as we have seen, dedicated to the subject of piano technique, will not misinterpret Ortmann's meaning.

[90] Ortmann claims that in this seemingly limited scope, there are actually many possibilities, because the acceleration of the key can be slow or fast, can be constant, or can be positively or negatively accelerated. *Piano Touch and Tone*, 16.

Chapter 9: Key Depression

It is at this point that Ortmann does a series of experiments of the depression of one single note. Assuredly, his scientific method is very outdated because in order to record the variations in key speed, he simply affixed a piece of smoked glass[91] to the side of the key and attached a tuning fork of known frequency to which a stylus was fastened.[92] As the key was depressed, any variation in wave length was recorded on the smoked glass. Because of the antiquity of the methods used, it is almost unavoidable that these experiments have some inherent measure of error. However, the results of the experiments show general trends, and Ortmann is basing his conclusions on these trends, not on any exact numbers.

With this set of experiments, he notes that with every increase in speed, there is a corresponding increase in dynamic range; in other words, the faster the key is depressed, the louder the resulting note will be. Ortmann also notes that under normal conditions, slower speeds, and correspondingly, softer sounds, are created with a relaxed arm rather than with a rigid arm.

As was referred to in the fourth chapter of this treatise, Ortmann classifies the touch used for key depression into two basic categories: percussive and non-percussive. The percussive touch he defines as one in which the finger moves from above the key to strike the key surface. The non-percussive touch is generally one in which the finger already rests on the surface of key in order to depress the key. He qualifies these definitions by saying that sometimes the line between the two is slightly blurred. Often, a slow moving finger or one that moves through a miniscule distance above the key has a

[91] Ortmann mentions that one kind of smoked glass that would serve the purpose would be a microscopic slide.

similar effect as the non-percussive touch.[93] Examining the different curves that result, he sees a marked difference between these two touches. The curves seem to indicate that in a percussive touch, the finger actually sends the key into motion with a slight jerk and then re-catches the key in its descent. While all of this happens on an almost imperceptible level, it does indicate that with a percussive touch, a pianist actually has less control over the key depression. In the percussive touch, the desired speed must be communicated at the inception of the tone; whereas, in contrast, with the non-percussive touch, the pianist is in contact with key during its entire descent, and thus can measure more accurately the desired speed. The resulting curves of this section of the experiments also show that generally the percussive touch results in faster key speeds and louder sounds than the non-percussive touch. Ortmann also mentions here, although he does not go into detail, that psychologically, due to the nature of the key contact, the percussive touch is more the result of a preconceived mental image, while the non-percussive touch allows for a more well-developed physical sensation.

Ortmann next raises the question of whether or not the depression of the key is constant or whether it changes once the key descent begins. Even taking into account the inherent resistance of the key and the friction in the action of the piano, a normal weight placed on a key would have to be considered a falling body and thus would have to accelerate due to the force of gravity. Of course, since the distance is so small from the top of the key to its limit, this acceleration would be very small. The player's arm also acts in some ways as a falling body, although the muscles of the arm are able to hold up its own weight and thus resist the gravity or to completely let go and let gravity act freely.

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[92] Ortmann does not mention the use of any stylus, but if the experiment was conducted without the use of the stylus, it is difficult to visualize how the tracings were made.
[93] *Piano Touch and Tone*, 20.

Thus Ortmann concludes that in a non-percussive touch, the player sets the key into motion gradually. He reasons that the way of producing sound often described by pedagogues as "clinging" to the keys, what Ortmann would call a non-percussive touch, produces better tone quality not because the approach inherently has a better sound, but because it provides the player with the ability and control needed to more carefully regulate the speed of the key's descent.

It is clear to anyone who has played on more than one piano that each piano has a unique feel, which depends among other things on the weight of the keys and the piano's regulation and condition. Additionally, any piano technician knows that all notes on even one piano do not offer the same resistance. In his next set of experiments, Ortmann wanted to "ascertain, in a general way, the extent of these variations."[94] He describes his scientific method:

> A metal cup of appropriate size was placed upon the key. Its weight was regulated by pouring small shot into it, and the key was released by removing a point lightly pressed against the outer surface, which ensured a fairly constant mode of release. The amount of shot was adjusted until the release of the key produced a barely audible tone. The threshold of audibility was set by two observers seated in the usual position at the key-board, and the numbers here used represent the averages of several judgments.[95]

Two pianos were used, both of which were supposed to be representative of the typical conservatory piano. Of course, Ortmann found that the amount of weight required on any one piano varied greatly. Generally the bass notes offered more resistance due to the increased size of their hammers. Interestingly, Ortmann was not just testing the weight of the keys at their edge, but also at other points along the key. In their function as levers, the keys offer the least resistance near their edge and more resistance as they are played

[94] *Piano Touch and Tone*, 35.
[95] *Piano Touch and Tone*, 38.

closer to the back edge, or closer to their fulcrum. Playing closer to the fulcrum decreases the mechanical advantage gained from the lever.[96] For example, Ortmann tested the weight it took to play a D Major scale played with the proper finger position, in other words, with the D played close to the edge, the E played slightly closer to the black keys, the F-sharp played on its edge, and so on, with the intention of maintaining a uniform intensity on every note. Not surprisingly, he found that "every key demands a different weight…if the resulting tones are to have the same intensity." So, in fact, pianists have to do a great deal of adjusting, not only from piano to piano, or from register to register, but also from tonality to tonality. For example, e-flat minor not only has a different fingering from D Major, it also has a radically distinct shape. This, in turn, would call for a singular finger position on the keys and a new range of key resistance. Ortmann also notes that similar experiments were done using the damper pedal, and that it was found that the weight of each key was .5 to 1 ounce less when the damper pedal was depressed.[97]

Ortmann also takes the time to consider whether or not it is possible to convey certain tonal descriptions, such as "thin" or "bright" in the production of a single tone. From the resulting curves, every difference in tonal description included a change in intensity or loudness. Therefore, all of these descriptive terms, while poetic and perhaps extremely useful for pedagogical purposes, are simply descriptions of the dynamic range of the note. Not surprisingly, the aesthetically less desirable sounds – ones corresponding to designations like "thin," or "brittle," and "harsh," or "ugly" – were at the exaggerated

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[96] This can be experienced by anyone on a playground see-saw. If a person sits on one end, anyone of a similar or greater weight will easily be able to pull him down using the edge of the opposite end of the see-saw. But even a person that outweighs the seated person may find it more difficult if he pushes down near the midpoint or fulcrum.

[97] This, along with the acoustical advantage of allowing sympathetic vibrations from the onset, may support the advice to have the damper pedal down before the first note is played on certain pieces.

extremes of the dynamic spectrum. The tones corresponding to positive designations, such as "singing" or "round," all fell within the mid-range of dynamics. Ortmann does not categorically dismiss all of these descriptive designations. However, because in a single tone they are invariably linked to intensity, he concludes that most of these designations are, in fact, results of a combination of tones.

Chapter 10: Aspects of Tone Production Outside the Player's Control

While it seems obvious that the human ear does not prefer sounds that either force strain or cause pain, the findings described above give even more evidence that the determination of tone quality is a changeable and subjective process, one that depends on more than just the actual recorded speed of the key.[98]

In fact, many other elements are completely outside the player's control. The role of the instrument builder has already been mentioned. Ortmann also points out many other aspects of tonal quality that are determined by factors other than the player. These include the make-up of the piano's sound itself, unwanted noises, and the surroundings in which the tone is produced.

It has already been established that the piano sound is not a pure sound. However, the piano sound is peculiar because its quality actually changes radically over its duration. The inception of any piano tone is made up of quite a bit of noise; it is not until a fraction of a second later that the sound becomes the complex sound so rich in partials that we know as the piano sound.[99] After about two seconds, the sound begins to decay rather rapidly. As the intensity quickly diminishes, the partials also fade away. This decay of sound cannot be avoided or controlled by the pianist, but it can be skillfully handled, which will be discussed in the next chapter.

Unwanted noises also affect piano tone. Certain acoustical phenomenon such as beats or sympathetic resonance can offer additions to the tonal result that the performer

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[98] The above findings are parallel to the conclusions with Ortmann's article "Tonal Intensity." One might ask why a hearing-impaired person can easily endure extremely loud and harsh sounds that an individual with a normal sense of hearing would not be able to stand. Does that turn the harsh sounds into "good" sounds? The only logical conclusion is that the overall result of tone production depends greatly on the subjective interpretation of the brain after the ear translates the given sound waves.

[99] Ortmann notes that even after only a fraction of a second, the tone is diminished in volume by more than half the original intensity. *Piano Touch and Tone*, 110.

intends. Beats, which were previously defined in Chapter 2, are caused when two pitches that have slightly different frequencies interact. The interaction of these two varying pitches actually causes fluctuations in the intensity of the sound. The human ear is capable of detecting six beats per second. Certain beats are unavoidable in our modern tuning system, which actually incorporates a lot of impure intervals, but sometimes unwanted beats are created when a piano is out of tune in an undesirable way. Sympathetic resonance occurs when certain frequencies on the piano cause other objects in the surrounding area to also vibrate, often causing unwelcome sounds during a performance.[100]

The noise involved in the playing the piano is a factor that is partially out of the player's control. In *Piano Touch and Tone*, Ortmann devotes the whole ninth chapter to noise. He divides what he calls the "noise element" into four elements: the impact of the hammer on the string, the impact of the finger on the key, the impact of the key against the key bed, and the friction noises of the action.[101] The second aspect of the noise element, the impact of the finger on the key, is the only one that is within the pianist's control, in the form of percussive and non-percussive approaches. The other three are outside of the player's command. Ortmann describes the hammer impact as a thud, one that is easily audible and may be easily isolated aurally. Of course, this hammer impact will increase with tones of louder intensity and decrease in extremely soft sounds, but it is always present. Since this initial hammer noise is an inherent part of piano tone, most

[100] In fact, at a concert in April of 2003 at the McCarter Theater of Princeton, New Jersey, Krystian Zimerman, the great concert pianist, was appalled during his performance because he heard some form of sympathetic vibrations. After intermission, he announced the realization to the audience, profusely apologized, and assured them that it was not his instrument causing the unwanted resonance, but some other object in the hall. It is well known that Zimerman tunes and regulates his own piano, and he actually carries this piano with him on tour. Clearly, Zimerman tries to limit the variables that he will encounter with each subsequent performance; however, as demonstrated by this occurrence, such an acoustical phenomenon is difficult to predict or control.

listeners do not isolate it consciously as a separate sound but rather hear it as part of the piano tone as a whole. The noise of the key upon the key bed is slightly less than that of the initial hammer strike, but it still forms a part of piano tone. Lastly, the noises of the action itself also affect the piano tone.

The surrounding area in which the sound is produced also affects the tone production. Sound can be both reflected and absorbed by the surrounding materials. Reflection happens when sound bounces off of other surfaces. The angle of this reflection depends on the angle at which the sound initially strikes the surface, and there must be a distance of about sixty feet between the sound source and the reflected source for the two to be heard as separate entities. Absorption occurs when the energy of the sound waves is absorbed by the surrounding objects and turns into heat energy. Most materials both reflect and absorb sound, but depending on their density and molecular structure, they will do this in varying degrees. For example, a tile surface would mostly reflect the sound and absorb only a small percentage of it. Carpet or tapestry, on the other hand, would absorb more sound than it reflects. When designing a concert hall, reflection and absorption of sound must be considered as well as refraction and diffraction of sound, two terms discussed in the first chapter on acoustics. Since refraction, the changing of direction of sound waves, can be caused by two layers of air that differ in temperature, temperature and humidity control are also factors when planning a concert hall. Because diffraction includes the bending of sound waves around certain objects, the size and shape of the hall would also affect the resulting quality of sound.

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[101] *Piano Touch and Tone*, 148. Ortmann also includes the impact of the finger upon the key, but this is within the control of the player to regulate.

Concert hall architects and acousticians have to deal with all of these factors in designing the performance space, but it is crucial that pianists are aware of them when performing in already constructed halls. Every performance hall will have its own parameters, so a pianist must adjust his own performance accordingly. For example, in a certain hall that lacks resonance, it may be advantageous to use more pedal in a certain passage. The same passage with the same amount of pedal played in an overly resonant hall might sound like an unclear, blurred mess. In addition, a pianist must be aware of the change in resulting tone that will occur between a certain empty hall and that same hall filled with people because of the fact that, acoustically speaking, audience members act as objects that absorb sound.

Chapter 11: Aspects of Tone Production within the Player's Control

SECTION 1: SINGLE TONE VS. COMBINATION OF TONES

Now after a thorough examination of the factors affecting tone quality that are mostly outside the player's control, we can turn to the elements of performance that are within a pianist's control. Although in the production of a single tone the only variables are key speed and duration, there are myriad possibilities when studying tone combinations. Ortmann discusses these possibilities first in the fourth chapter, and then, more extensively in the eighth chapter, of *Piano Touch and Tone*. In Chapter 4, he classifies most tonal combination effects into two categories – "simultaneous key depression or successive key depression, representing, respectively, the harmonic and melodic aspects of piano playing."[102] While simultaneous key depression can vary only in key speed of each note depressed, successive key depression can vary in both key speed and the time interval between the successive key depressions.

Simultaneous key depression would involve either simply playing a chord or playing a chord with a melody note on top. Two techniques, voicing and balance, are available here for the pianist. Voicing is the technique in which one note in a chord is brought out above the other notes in the chord; in other words, one note has significantly more key speed than the other notes in the chord. Balance is a similar technique that generally involves both harmony and melody in which the melody note is given more key speed than the harmony notes. The more notes involved in a given chord, the more possibilities exist for variation in tone quality.

Successive key depression is what is incorporated in melodic playing. Obviously, key speed is still a factor since a melody is just a chain of single tones. In melodic playing, varying the key speed of successive notes opens up all sorts of possibilities for shaping phrases. Also, in melodic playing, the time interval in between notes can be altered. Certain effects, such as *rubato* or *accelerando* involve variations in this time interval. Ortmann notes that other indications, such as *calando*, would call for modifications in both key speed and time interval.[103] In successive key depression, while manipulating both key speed and the time interval between tones, pianists must be very aware of the nature of the piano tone to gradually die away. This innate quality of piano tone can work either to a pianist's disadvantage or to his advantage. If, for example, a pianist is not keenly aware of the decay of the first sound he produces, the next sound may be significantly louder and thus will stick out, upsetting any melodic flow. However, if the pianist is aware of the decay, he can use that to slightly delay a climactic note or chord of the phrase, which will allow the previous sound to die away a little more, in turn causing the climactic moment to sound louder.[104]

It is in the eighth chapter that Ortmann notes the "inexhaustible field of tone-colour"[105] available when two tones are combined, either overlapping at different time intervals, or played simultaneously. For two of the same tones, a different blend of sound occurs with each degree of overlap since the piano tone is not a pure or constant tone, but one that changes quality from moment to moment. Ortmann provides a rough visual aid of these different possibilities (See Fig. 11). Two tones played overlapping at the same interval but played with different intensities will also yield different tone combinations because louder intensities have more upper partials than softer intensities. Changing the pitch of the two tones will also cause a change in the sound mixture, not

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102 *Piano Touch and Tone*, 50.
103 *Piano Touch and Tone*, 53.
104 Randall Wolfe, "The Pianist's Control of Tone Quality," D.M.A. Diss, The University of Cincinnati, 1991, 35.

only because higher pitches have fewer overtones than lower pitches, but also because the rate of decay of sound is different for different pitches. This can easily be determined by sitting at the piano and timing two notes of the same intensity from their initial depression to the point where the sound becomes inaudible. High notes will last much less time than low notes.[106]

Obviously, the overlapping of some notes will occur as part of any composition, as note duration is indicated by the composer. However, the practicality of overlapping tones to enhance a melodic line has always been a topic of intense debate among pianists and pedagogues. Some feel that by slightly overlapping two tones, the pianist is able to somehow mask the initial percussive quality of the second tone to some degree. Others feel this is not remotely necessary and that this technique just leads to blurred, unclear playing. This dispute will be further considered in the chapter about legato playing.

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[105] *Piano Touch and Tone*, 131.

[106] This can easily be tested on any piano. On a Steinway B, at the dynamic of *f*, the highest note on the piano will be audible for 4-6 seconds, the lowest for 16-20 seconds.

SECTION 2: USE OF THE PEDAL

Ortmann concedes that the use of the pedal is another way of altering the tone quality, one that is also within the player's control. Not only does the damper pedal allow the pianist to sustain notes that he would otherwise be unable to sustain, but it also adds richness to the tonal complex by adding the resonance of tones other than the ones actually struck. Ortmann calls this "a conspicuous and beautiful example of free resonance."[107] When the damper pedal is depressed, the dampers inside the piano are lifted. As we have seen, this allows strings other than those of the struck notes to vibrate sympathetically. Ortmann notes that while the overall effect of the pedal will differ from instrument to instrument, the pianist can influence the timing of the pedal. He points out that a pedal depressed at the inception of the tone will produce richer color than a pedal placed sometime after the tone's inception because the strength of sympathetically sounding vibrations is directly proportional to the initial intensity of the original struck tones.

Ortmann only briefly mentions the effect of the *sostenuto* pedal, saying that it has similar prolongation effect as the damper pedal, but a diminished effect in terms of color possibilities. However, he does devote a paragraph to the use of the *una corda*. As mentioned before, when the *una corda* is depressed, the entire action shifts over and the hammer hits only two of the three strings. Primarily, this causes a softer tone because only two strings are being struck as opposed to three. Also, the less used part of the hammer that strikes the two strings is not as compressed as the part typically used, so the resulting sound is slightly less brilliant. Ortmann points out that this might also be due to the difference in the noise element between the harder and softer parts of the felt striking

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[107] *Piano Touch and Tone*, 136.

the string.[108] Lastly, the third string vibrates sympathetically with the two strings that are struck. All of these factors will affect the tone quality and allow the pianist to add yet another color to his palette. Ortmann does point out that on a new piano, since the hammers are uniformly unused, the change in color afforded by the *una corda* will not be as distinct as on an older piano.[109]

The exploration of the acoustical results of these many factors, both those that are out of the pianist's control and those that are within his influence, is a fascinating and almost limitless study. Pianists must be aware of all of these issues in order to more intelligently craft their art. In addition, the physical approach to tone production also must be studied. Since pianists must use their bodies to physically produce sound, muscle structure and physiology must be thoroughly analyzed. While the first step is to know what possibilities exist in tone production, the next and indispensable step is to comprehend how physically to obtain the desired result.

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[108] *Piano Touch and Tone*, 139.
[109] *Piano Touch and Tone*, 140.

SECTION 3: PHYSICAL ASPECTS OF THE PIANIST

Although Ortmann often states in his books that the physical way a pianist approaches the keyboard is irrelevant to tone quality as long as intensity and duration are controlled in the desired manner, he goes beyond this conclusion, acknowledging that the piano must be played in a certain physical way due to certain physiological principles that govern the muscular system as well as other systems of the body. In this section, four selected physiological elements related to tone production will be examined: relaxation, vertical and lateral movements, finger position, and key release.

Ortmann devotes an entire chapter to relaxation. Using a device called a mechanical arm, he was able to observe and analyze arm movements. He is quick to defend the benefits of such a device:

> I cannot urge too strongly the use of such an instrument: it reveals in a striking manner many widely accepted fallacies of the mechanics of arm movement. The criticism will immediately be made that such an instrument does not reproduce at all the complex physiological mechanics of the arm itself, hence its study cannot lead to practical conclusions. The premise is true enough, but not the conclusion. Since the joints of the fingers, wrist, and elbow are all hinge-joints, some entirely, some primarily, a mechanical arm with hinge-joints reproduces faithfully the simple mechanics of the movement.[110]

In this chapter, Ortmann delivers many principles which he acknowledges go against standard pedagogy. First, he asserts that any position of the forearm, other than its completely relaxed position hanging vertically at the side of the body, requires some amount of muscular contraction. Thus, complete arm relaxation at the piano is impossible because simply to bring the hand up to the keyboard requires muscular contraction.

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[110] *Physiological Mechanics*, 124.

Ortmann goes on to explain that what pianists normally describe as resting on the keys is not truly a relaxed state either, because in order to keep the arm weight supported in the finger tip, one or more joints must actually be mildly fixed. When the arm is held above the keys, the shoulder holds much of the arm weight, and when it is put into the keys, the fingertips hold some of the arm weight.

By applying the principles of inertia, Ortmann maintains that for rapid successive production of tones, the mass of the playing units must be reduced to a minimum. If the playing units have less mass (for example, only the wrist as opposed to the forearm), they also have less inertia, and it takes less muscular contraction to move an object with less inertia. However, playing with the minimum mass also requires a certain degree of fixation, which again eliminates the possibility of a completely relaxed arm.

In Chapter 8 of *Physiological Mechanics*, Ortmann discusses vertical and lateral arm movements. He divides the vertical movements into four contrasting movements: "arm-lift," "free arm-drop," "controlled arm-drop," and "forced down stroke."

The first, "arm-lift," is simply the movement to bring the hand up from a perfectly relaxed position, hanging at the side of the body, to the key. Many muscles of the shoulders, back, and upper arm are involved to bring the arm above the key. Ortmann describes the motion:

> The abductors and rotators of the upper arm, situated chiefly between the neck and the shoulder, contract to counteract the effect of gravity. In the case of the abduction, the upper arm lifts sideways from the body, raising the elbow to a plane level with, or above the keyboard. In the case of forward rotation, the upper arm rotates in the shoulder-socket, bringing the elbow forward and upward. The two movements are normally combined and involve the activity of practically the entire muscular system of the shoulder.[111]

[111] *Physiological Mechanics*, 149.

In this natural arm-lift, the hand will be hanging loosely from the wrist. Since so many muscles interact, this further proves that there is no truly relaxed movement in piano playing. Ortmann also points out here that it is useless to talk about muscular isolation, "such as a single finger-stroke," because all muscles are interconnected.

The "free arm drop," a term that has been used loosely and perhaps inaccurately by many pedagogues, is defined clearly in Ortmann's next section. The beginning point is directly after the arm lift, a state in which the hand hangs limply down from the wrist over the keyboard. If allowed to fall using only the effect of gravity, the arm would fall uncontrolled, and the fingers would simply slide off the keyboard. In order to stop on the keyboard, some amount of fixation must occur. Thus Ortmann concludes that "the completely relaxed arm-drop…plays no part in piano technique."[112]

He has a higher opinion of the utility of the "controlled arm drop." The controlled arm drop begins gradually and never reaches total abandon in descending speed like the free arm drop. Ortmann draws attention to the fact that if there is no cushioning in the wrist there will be a clear "jerk" in the wrist as the fingers arrive to the keyboard. This percussive shock can be greatly reduced by allowing the wrist to fall below the keys. Ortmann relates this to tone production:

> Physically, so far as fine tone control is concerned, the non-percussive character of the relaxed descent is undeniably better. And physiologically, absence of shock is likewise desirable. On the other hand, the tonal intensity desired may make rigidity necessary, and with rigidity must come the shock of impact.[113]

The last vertical descending motion that Ortmann describes is the "forced down-stroke." This is one in which the muscles contract by force and, combined with gravity, cause the arm to fall much faster than even in the free arm drop. The arm is, in effect,

[112] *Physiological Mechanics*, 151.

thrown into the keys. Ortmann finds that this motion is useful for realizing *fortissimo* chords at a relatively fast speed.

Ortmann clearly indicates that lateral movements at the keyboard are not simple horizontal movements, but instead combine some elements of both the vertical and horizontal. He assigns the difficulty in such movements to the change in direction. Applying the rules of inertia and motion, this abrupt change interrupts any principle of smooth mechanical motion since a loss of velocity always occurs in a change of direction. Ortmann suggests that in order to eliminate any loss of velocity, there must be actually no stopping in the movement. Thus, straight line movements with sudden change of direction must be rounded out to approximate curved movements. To move from one point on the keyboard to another and back again would then approximate a flat figure-eight shape. The only distinct sharp points would then be the point where the fingers actually touch the surface of the key. In this study, Ortmann recorded the movements photographically, using a small light bulb attached to the player's fingers, hands, or arms. He assures the reader that the pianists recorded claimed that the apparatus did not hinder their free movement at the keyboard. In the photographs obtained, the curved movement described above can be seen.

Ortmann classifies finger position in two ways: flat finger stroke and curved finger stroke. In the flat finger stroke, the finger is fully extended from the knuckle and no movement takes place at the middle joint or at the nail joint. Ortmann classifies it as a lever of the third class, with the force being applied between the fulcrum and the distance. In this finger stroke, what a pianist may gain in speed, he will lose in force. Ortmann concludes then, that this finger stroke is valuable to produce soft tones, but if

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[113] *Physiological Mechanics*, 153.

loud tones are produced, the pianist is working at a mechanical disadvantage. Ortmann reiterates here, however, that because in the flat finger stroke the cushion of the finger tip comes in contact with the key, the stroke is ideal to reduce the percussion of the finger impact on the key and is conducive to producing "singing" tones.

The curved finger stroke is curved in all three joints: the knuckle, the middle joint, and the nail joint. Again, the finger in this position can be seen as a type of lever. In the curved finger stroke, the force is nearer the fulcrum, and the force will have more effect. The curved finger stroke will have some increase in percussive noise due to the finger tip contacting the key, as opposed to the finger cushion, but Ortmann suggests that this percussiveness is partially alleviated because less force is actually required to produce the same intensity of sound.

In terms of key release, Ortmann concludes that the speed of the ascent of any key is fixed unless purposefully retarded. Thus a pianist can control only the point at which the key is released and can slow down its ascent but cannot quicken its ascent in any way. Even if the key is released suddenly, its ascent will be fixed. The only difference will be the percussive noise of the key returning to its starting position. Ortmann is defending this position against an errant line of thought in which the keyboard was viewed as an elastic body, one in which the key ascent was a result of elasticity and compression due to its original descent. Instead, Ortmann explains that the key rises because of its lever function. Because the inner side of the lever is heavier than the visible side, it is pulled down by gravity when the resistance on the visible part of the key is removed. Of course, the pianist can delay key ascent to the extent preferred, but he cannot accelerate the ascent any more than its already fixed speed.

Now that the foundational physical movements to produce tone at the keyboard have been analyzed, the two types of touch forms, namely *legato* and *staccato*, will be analyzed. While other touch forms clearly exist in piano playing, such as *non-legato* or *portato*, these can be seen as variations or different degrees of *legato* or *staccato*.

SECTION 4: DIFFERENT TYPES OF TOUCH

Although the difference between *legato* and *staccato* can perhaps be readily heard because of the difference in time interval and space in between each note, it is necessary to study the physical ways to achieve these touch forms in the most efficient way possible.

Ortmann describes *legato* thoroughly; in fact, he devotes a whole chapter of *Physiological Mechanics* to "arm-legato." This touch, which he associates with realizing a *cantabile* melody, consists of a full, singing tone of middle dynamic range. In this touch form, the fingers never leave the keys, but the arm stays unfettered. The purpose of this form of legato playing is not simply to eliminate the space in between notes, but to eradicate any percussive noises of the finger striking the key. Many of his conclusions in this section sound similar to his line of reasoning on relaxation. Ortmann contends that this kind of arm-legato requires some kind of muscle contraction:

> Therefore, the weight of the arm, and the contraction of the arm-depressing muscles are brought into play.[114]

However, he warns against any kind of unwanted jerk or "shock" of the wrist. Ortmann holds that with the proper adjustment of finger, wrist and arm, all percussive nature of the tone can be eliminated. If however, the wrist remains rigid, the shock of the finger impact is simply relocated to the wrist, which then abruptly stops. He concludes that in order to fully obtain the ideal form of this touch form, the arm must be utterly relaxed. If he had stopped there, he would have sounded a lot like Breithaupt or Matthay, but he goes on to clarify. He explains that although some believe that in order to play with a relaxed arm, the entire mechanism – that is, finger, wrist and hand – must also be fully relaxed. Ortmann vehemently disagrees:

> This is not true, the finger joints are most decidedly not relaxed, and the wrist joint only partially so.[115]

He proposes that pianists feel the sensation of relaxation because the greater part of the feeling comes from the place at which the larger motion takes place, in this case at the shoulder joint.

As was mentioned earlier, whether or not the slight overlapping of tones actually aids in refined legato playing is the subject of a controversial debate. Those like Matthay have argued that it indeed is the only way to achieve a true *legato*. Others have dismissed the idea altogether. In fact, Jacob Helmann almost ridicules the concept:

> As a result, instead of a great quality as perfect *legato* should be, a phrase in "enriched" with absurd dissonances because each sound drags with itself a remnant of the previous sound, badly destroying the clarity in any composition.[116]

Ortmann does not include here any lengthy description of any kind of overlapping of tones, but he does specify that the point of any *legato*, beyond just a reduction of space in between notes, is the reduction of the percussive noises of finger impact. Of course, overlapping to the point of creating dissonances would be utterly wrong, but it seems that if there is some sort of middle ground that aids in masking the percussive noise of the proceeding note – such as a slight overlapping in which no dissonance is audible – this would be a useful tool for the pianist to employ.

Ortmann also spends a short chapter analyzing the *staccato* touch. He begins with a classification of *staccato* touch, one that includes shortness of tone and separation of each tone from the preceding and following tones. He clarifies:

> A tone merely short of duration, but connected to some other tone is not a staccato tone, regardless of its own agogic value. Nor is a tone *staccato*

[114] *Physiological Mechanics*, 177.
[115] *Physiological Mechanics*, 179.
[116] Helmann, *The Consciously Controlled Piano Tone*, (Denver, Colorado: Columbia Press, 1950), 30.

> when it is merely separated from the other tones. Both brevity and tonal isolation are necessary for a true staccato effect.[117]

This seems clear enough to the reader, but like a good scientist, Ortmann is defining the limits of his discussion so that there can be no doubt. Because *staccato* touch is different from *legato* depending on the key release, Ortmann reiterates the assertion that the ascent of the key cannot be accelerated by a quick release of the key.

Ortmann goes on to classify staccato touch into three categories: hand staccato, arm staccato or finger staccato. In hand staccato, as seems obvious by its designation, the hand is the playing mechanism. The forearm and upper arm are held relatively stationary, while the hand moves up and down on the hinge of the wrist. Ortmann specifies that in order to overcome the resistance of the keys, the finger joints must be somewhat rigid. If the wrist is fixed, however, this will hinder the up and down motion of the hand, and Ortmann cautions that this will lead to a tired wrist.

Arm-staccato is a technique in which the forearm or the whole arm is thrown into the keys. In this movement, the wrist must remain fixed. Because this movement requires the use of a greater mass, more muscular contraction will be needed to change direction after the fingers impact the keys. Therefore, for rapid *staccato* passages, this larger movement would be less favorable than the smaller, more economic hand or finger staccato.

The finger staccato is one in which only the finger is used. Ortmann cautions here that overuse of this technique can lead to fatigue because in *staccatissimo* effects, the muscles controlling finger lift are forced to remain in some form of contraction throughout.

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[117] *Physiological Mechanics*, 196.

For all three *staccato* touches that he describes, Ortmann identifies the release of the hand as the "positive phase." Although tone production, as in every touch, is the aim, the staccato effect depends on the termination of the tone, so Ortmann advises that all the attention of the player should be on the up-stroke. Although Ortmann does not go into further detail about this advice, it seems that focusing on the up-stroke would also be psychologically beneficial, preventing over articulation or forced *staccato* touches by shifting the focus away from the movement down into the keys, an action often interpreted as being a lot of work.

PART FIVE: SELECTED RESEARCH TRENDS FROM THE SECOND HALF OF THE 20TH CENTURY

Obviously, the history of piano pedagogy and pedagogical treatises does not end with Ortmann. After his two books were published, many other authors published their own methods and treatises, each adding a unique voice and a particular set of opinions. It is imperative to cover some of these publications in order to trace Ortmann's influence on the scholarship that came after him. We will investigate the following questions: Was the issue of tone production "settled" after Ortmann's scientific treatment of the subject? Have any significant contributions or additions been made to his research? Has anyone tested his findings using a comparable, while more modern, scientific approach?

In order to compare different approaches, we will examine some selected pedagogical treatises below, from pedagogues such as Josef Lhévinne, who wrote his classic *Basic Principles in Piano Playing* in 1924, to Alan Fraser, whose *Craft of Piano Playing* was just published in 2003.

Lhévinne, the renowned Russian pianist and teacher, emphasizes the important role of the wrist in the production of a good tone, what he coins as the "ringing, singing tone."[118] He compares the wrist to the shock absorbers in an automobile, singling out the "bump" that results from a stiff wrist as the ultimate obstacle to a good sound. He comes to similar conclusions that Ortmann does by way of instinct as opposed to scientific analysis. Lhévinne writes humorously that "the piano is not a typewriter to be thumped upon."[119]

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118 Lhévinne, *Basic Principles*, (New York: Dover, 1972).
119 Lhévinne, *Basic Principles,* 21.

Lhévinne also mentions the effect of the release of the key on the tone. If the key is depressed correctly, but is released in a jerky fashion, tone production is hindered. He offers the image of the arm "floating in the air" in order to obtain an even and delicate touch, but he is quick to remind the pianist that all keys should still be played to all the way to the key bottom."[120]

Heinrich Neuhaus, in his book, *The Art of Piano Playing*, asserts that the muscular condition for a good tone is one of complete relaxation. The arm and the wrist should be loose, and there should be no tension from the shoulder to the tip of the finger. He warns that this relaxation cannot be confused with a lack of focus:

> The tips of the fingers should always be ready, like soldiers at the front. (After all, the decisive factor for tone quality is the contact of the fingertips on the keys; the rest – hand, wrist, arm, shoulders, back – that is "behind the lines" and must be well organized).[121]

Though Neuhaus does not present any specifics on finger position, he does discuss variety of touch in terms of voicing chords and tone layering between melody and accompaniment. He accentuates the importance of developing proper voicing and developing an "air cushion" in between melodic and harmonic figures. There is no science in Neuhuas' approach; the book is filled more with inspirational imagery – anecdotes and advice from a well-seasoned pianist and pedagogue.

Gyorgy Sandor, the famous pupil of Béla Bartók, in his book *On Piano Playing*, dedicates an entire chapter to the "free fall" of the arm. He holds that there are only two possible sources of energy at the piano: gravity and our own muscular system. He recognizes that most often pianists must combine the two, but he advocates utilizing gravity whenever possible to conserve muscular energy. Sandor states that the only way

120 Lhévinne, *Basic Principles*, 27.
121 Neuhaus, *The Art of Piano Playing*, (London: Barrie and Jenkins, 1973), 69.

to affect the volume of the sound is to influence the speed of the hammer hitting the string and accordingly the speed of the key. He writes:

> The notion that the full weight of the arm produces more sound than a lighter weight is erroneous.[122]

He therefore defends his position that it is actually beneficial to use as little weight as possible. He describes the free fall as being a complete range in motion in which the only time there is complete relaxation is between the lifting and the landing. For in the lifting, the muscles must actively work, and after landing the muscles must instantaneously contract in order to stop the free range of motion[123] and somehow cushion the impact. He cautions that this kind of drop is not a completely relaxed action, something similar to Ortmann's "controlled arm drop." He warns that there should be no interference with the movement, either acceleration or deceleration, instead the "sheer force of gravity [should] act upon it."[124] He categorizes the motion into three stages: lifting, dropping, and landing/rebounding. In the first stage, he recommends using the least possible outflow of energy. He writes that the movement is a successive one, first the upper-arm raises, followed by the forearm, and finally the hands and the fingers. He states that the quality of the sound depends on to what extent the various joints of the arm and fingers are fixed. If they are too loose, the resulting sound will be shallow; if the joints are excessively rigid, the sound will be too harsh. He does not specify here that this result on the tone would be due to the varying speed of the key. The second stage of "dropping" is a simultaneous movement, as opposed to the successive quality of the lifting. This stage is completely passive – the moment of relaxation that Sandor pointed to earlier. The third stage is the landing, at which point Sandor observes a momentary fixation of the joints in

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122 Sandor, *On Piano Playing*, (New York: G. Schirmer, 1981), 38.
123 In other words, without some amount of contraction upon landing, the arm motion would simply continue, carrying the hand and fingers past the keys.

order to transfer the energy into the keys. There is also a rebounding motion of the wrist, though the fingers stay on the surface of the keys.

Later in his book, Sandor includes a chapter entitled "singing tone." He begins the chapter by acknowledging the ongoing debate as to whether the mechanism of the piano actually allows for any variety in tone color. He claims that although the piano is a percussion instrument, it is somehow able to respond to the widest range of human emotions. He does not elaborate upon this premise too much, but it is clear that he holds some contempt for those who try to scientifically categorize piano playing. He writes:

> While everyone agrees about the piano's capability to vary dynamics from triple piano to triple forte, its ability to vary tone color is a topic that is quite controversial. It has been "proven" by some "experts" that it is only the volume of the sound that can be altered and that altering tone quality is purely a matter of imagination.[125]

In spite of the seeming sarcasm of this last sentence, he does concede that this may hold true for the production of one note, but passionately argues that there are differences between artists' individual playing. He writes:

> Perhaps it is caused by the rate of acceleration of the speed of the hammers; perhaps it is the way the damper stops the sound when it descends on the strings; perhaps it is the spacing of notes, the agogic qualities of the playing, or the flexibility of metric units…but differences do exist![126]

The rest of his chapter on tone is filled with cautionary advice for avoiding common mistakes in tone production. At this point, Sandor isolates intensity as being the most important quality in singing tone. He writes that the tone "should have body, it should be expressive, and it should have an expressive quality."[127]

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[124] Sandor, *On Piano Playing*, 41.
[125] Ibid., 14.
[126] Ibid., 14.
[127] Ibid., 180.

He warns that the joints should be resilient, not too soft or too hard, and should cushion the downward energy in order to reduce the speed of the key. Like Neuhaus, he clarifies that he does not mean for the fingers to be limp. He also counsels against mistaking the necessary cushioning action for a pressure on the keys, reminding his readers that on an instrument that produces sound by an instantaneous hammer action, pressure into the keys after the initial attack is not only useless but also harmful, because of the extended tension and strain it produces in the muscles.

Although many of the principles that Sandor discusses are right in line with the thinking of Ortmann, nowhere in his discussion on tone does Sandor reference Ortmann by name.[128] However, if he was including Ortmann as one of the "experts" about which he made his previous remark, it seems clear that he misunderstood Ortmann's writings, because Ortmann does clearly mark a difference between the possibilities involved in the production of one single tone and how that changes in the production of more than one tone. As can be seen by comparing many of their conclusions, often Sandor's ideas are similar to many of Ortmann's findings.

Joszef Gát, Hungarian pianist and harpsichordist, in his method *The Technique of Piano Playing,*[129] also begins his discourse on tone production with reference to the ongoing debate about whether the quality of the tone can be changed on the piano. He traces one side of the debate to Eugen Tetzel from the early twentieth century." As we have seen, Tetzel advocated that tones of different volumes can be produced on the piano, but not tones of different colors. Gát even acknowledges the fact that numerous physicists conducted experiments on the subject and all came up with the same result.

[128] In fact, he does not even provide a bibliography anywhere in his book.
[129] Gát, *Technique of Piano Playing*, trans. Istvan Kleszky, (London: Collet's Publications, 1974).

However, he brings up the surprising opinion that although the results of the experiments may not have been incorrect in and of themselves, they cannot be accepted as truth since piano playing cannot be explained rationally. While Gát does not mention names, he may, like Sandor, be referring to Ortmann or the others who conducted experiments supporting Ortmann's conclusions. Gát himself cannot offer any proof against Ortmann, but he seems to dismiss his scientific efforts by supporting this last illogical argument.

In another section of the book, he discusses "swing strokes of the upper arm." In this section, he echoes many of the ideas presented by Sandor and Lhévinne. However, he differs quite a bit from Ortmann in his ideas on finger position. He identifies two positions – "flexed" (curved) and "extended" (flat) – and erroneously assumes that the "flexed" position requires more muscle activity, so it is not as favorable for velocity as the "extended" position. He holds that the extended position is also of more advantage for tone volume because larger movements can be achieved with smaller muscular exertion. This opinion, while held by other pedagogues and performers alike, contradicts Ortmann's scientific application of the lever and fulcrum principles as applied to the finger.

In his book *Piano Notes*, the famous scholar-pianist Charles Rosen offers only a few ideas on the physical aspect of tone production. He does, however, oppose the commonly accepted tenet that in order to produce a beautiful sound, one must possess a relaxation of the arm and a gentle touch. Instead, he says that in order to create a good sound, one must simply balance the notes of a certain chord to bring out the significance of various harmonies. He does not grant that these variations in chord balance may be extremely difficult to achieve with a stiff and rigid arm.

Boris Berman, who heads the piano department at Yale University, goes into great detail about the specifics of physical action in tone production in his *Notes from the Piano Bench*. In fact, he includes an entire chapter on the subject. He does not include any scientific information in his book; instead, it is a "reflection of [his] personal and professional experience."[130] Berman chooses the words "in" and "out" to describe the different approaches to the attack of the key. The "in" sound demands a slow and continuous motion. Berman recalls two imaginative descriptions of this motion – Josef Hofmann describing it as a sound produced by pushing through a very ripe strawberry and Rachmaninov likening it to growing roots from the fingers into the keys. Berman adds:

> The "in" type, then, is based on a slow immersion in the keyboard: the action continues even after the sound has been produced, as if the moment of attack were ignored."[131]

The "out" type that Berman describes is quite different. This sound is created by a rapid movement in which the finger leaves the key almost before the note sounds. Berman recommends using a circular motion to accompany the "out" sound – playing from an angle or caressing the key. Berman declares that although these two types of sound do not appear in their simple form, they are the basis for the countless combinations of touch. Berman stresses the importance of awareness of physical motion. He thus proceeds with an extremely informative list of many factors which the pianist should bear in mind. This list is summarized and paraphrased below:

1. Weight: Berman completely disagrees with Sandor, asserting that the more weight that is put into the key, the fuller the sound will be. Therefore, he

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[130] Berman, *Notes from the Pianist's Bench*, (New Haven: Yale University Press, 2000), ix.
[131] Ibid., 5.

recommends experimenting with using the right amount of weight for each varying passage. He does not relate the weight of the arm to the speed of the key.

2. Mass: This includes the amount to which a body is involved in sound production. A sound can be produced using just the finger, or fingers combined with the hand, the forearm and the upper arm in order to achieve a fuller sound.
3. Speed: Berman holds that the fingers cannot produce sound from a resting position on the surface of the key. Especially in louder passages, he feels that from the surface of the key, fingers can only push the keys down, which will result in a strained tone.
4. Perception of depth: Berman writes that one should not play with a deep sound in loud passages and a shallow sound in soft passages, but there should always be some sort of perception of the bottom of the key. Like Neuhaus, he warns that this should not be mistaken with pressure, which results in a forced tone.
5. The shape of the fingers: Berman remarks that in order to play more articulated passages, a curved finger is beneficial, and to create a warm singing tone, the fingers should be in a flatter position. He mentions that whatever the position, the fingers should always be "alert."

Berman does not mention Ortmann by name at all, although he agrees with Ortmann on certain concepts. It seems as though, instead, he is more interested in the inspirational and musical advice he can impart to students, the kind of knowledge that he has gained from experience rather than through research.

Alan Fraser's *The Craft of Piano Playing* has been hailed as "the most detailed and intensive study on the subject since Otto Ortmann's seminal work."[132] Fraser, a professor of piano at the University of Novi Sad in Yugoslavia, bases much of the book on the Feldenkrais method.[133] He does offer interesting insights into the physical acts of tone production. He considers the concept of using arm weight to produce beautiful tone to possess much truth, but also to carry the potential for much misunderstanding and pianistic dangers. First, Fraser questions the nature of the free arm:

> Is dropping the weight of your arm into the key to produce the most beautiful sound really free? Well, maybe – just like jumping out of a plane without a parachute is free![134]

He clarifies that the weight in a free fall might be free, but it is also the most dead, and that the maximum freedom is perhaps not necessarily the most desirable. He writes:

> Our goal is not uncontrolled freedom but a *capable* freedom – to create pianistic, dramatic color with maximum variety.[135]

He explains that while arm weight plays a vital role in production of good sound, it is not 'dead' weight, but rather a flexible, alive, discerning weight. He agrees with many of the other theories discussed above that the muscles must be relaxed in order to move freely. But he also brings up the possibility of arriving at the other extreme, in which too much relaxation can be disastrous; everything is so relaxed that "the muscles simply do not move enough to do their job."[136]

Fraser emphasizes the importance of physical awareness in piano playing more than any of the other books covered. He asserts that all physical movements affect the

[132] Review of Fraser's *The Craft of Piano Playing*, "The Pianist's Bookshelf," *Piano UK* (November/December 2004): 17.
[133] The Feldenkrais method is a method that combines physical movement and mental awareness, meant to make movements of everyday life easier and more efficient.
[134] Fraser, *The Craft of Piano Playing*, (Lanham: Scarecrow Press, 2003).
[135] Ibid., 40.
[136] Ibid., 41.

sound that is produced, thus the more awareness one has of the body, the more one can direct muscles and develop a deeper sensitivity.

Considering all of the above writings, the influence of Ortmann is hard to see. Most do not acknowledge Ortmann even when their thinking is in line with his research. In many ways, they continue to provide mainly experience-based pedagogy as if he had never existed. Ortmann's principle that piano tone color can be altered only through intensity and duration of a sound is still viewed with much suspicion, mainly because of the failure to recognize that Ortmann was limiting his study to the production of a single tone. Also, Ortmann's discussion of noise has been greatly ignored. In fact, William Hill, in an influential article for the *Musical Quarterly* from 1940,[137] entirely misses Ortmann's treatment of the subject. He claims that although it had been many years since the discussion of tone quality had been settled, "those who discuss tone quality have been strangely prone to neglect the obvious fact that a very conspicuous element in the sound produced by any instrument…is not tone…at all, but noise – pure and simple."[138] As has been discussed before, Ortmann had already devoted an entire chapter to noise in *Piano Touch and Tone* fifteen years earlier.

However, in almost all of the methods and treatises discussed above, a general balance can be seen between relaxation and finger articulation. They speak of relaxation but warn against too much relaxation. They talk of arm weight, but caution that fingers must be alert. Somehow they all fit in the middle between the old finger school and the school of arm-weight led by Breithaupt. This tendency shows, whether acknowledged or not, that all were influenced in some way or another by Ortmann's works or at least by

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[137] Hill, "Noise in Piano Tone, A Qualitative Element," *Musical Quarterly* 26 (1940): 244-259.
[138] Ibid., 248.

the pendulum swing he initiated. In the introduction to the 1962 reprint of *Physiological Mechanics*, Schultz sums up the influence Ortmann had on his own writing:

> In point of fact, I could not have written my book at all but for the fact that Ortmann had first written his.[139]

This concession may very well apply to most of the pedagogues referred to in this section. Ortmann opened the door to a new era of scholarship on piano playing, and in many ways, it is because of his work that successive works were possible.

[139] From the introduction to the 1962 reprint of *Physiological Mechanics*, xxvi.

PART SIX: A BRIEF LOOK AT PIANO TONE PRODUCTION IN THE HISTORY OF PIANISM

Clearly, because this treatise is designed to focus on Otto Ortmann's writings and research, in the previous chapters there has been much analysis and discussion of his work with frequent mention of work by other noteworthy pedagogues and scholars. However, there has been little mention of tone production in actual practice; in other words, how the great pianists throughout time have wrestled with the issue of tone production and how their understanding or instinct manifested itself in their playing. It seems the treatise has been all about piano playing without one real instance of music! Unfortunately, because recording technology was not perfected until just over a hundred years ago, our exploration has to start with the pianists of the early twentieth century. Any inclusion of other great pianists whose legacy is not engraved in sound recordings, such as Franz Liszt or Clara Schumann, would simply have to be based on written secondary sources. With recordings, however, listeners are granted exquisite primary sources, ones that can tell a story without a single word.

The main question of this chapter is whether or not the influence of Ortmann's research can be traced in the performance of great pianists. Certain pressing and fascinating questions present themselves. For example, why were the early 20th century pianists, such as Cortot, Lipatti, Paderewski, Gilels, Rachmaninov, Rubinstein or Rosenthal revered and praised for their superb tone at the piano and hailed as the masters of a Golden Age of the Piano? When doing comparative listening, why is it that so often, the recordings from that era do possess a kind of magic in the tone, while recordings of many modern pianists sound almost sterile in comparison? Of course this is a matter of opinion, and some readers may heartily disagree with this assertion. However, based on this opinion, many more questions come to light. Is this difference a result of a heightened awareness of the importance of tone quality in the early 20th century? Did scientific researchers like Ortmann, by claiming that tone quality was only a result of intensity and duration, lessen the art of piano playing in such a way that pianists who came afterwards lost some element of magic?

Of course, there are no clear answers to these questions. A few factors must be initially mentioned and may be partly or wholly responsible for the differences between old and modern recordings. First, as was mentioned previously, although the modern piano is strikingly similar to the one that was in existence even in the early 20th century, there have been small changes in the piano's design. However slight the changes, they could account for some variation in tone quality. Another major difference is the evolvement of recording devices. Analysis of this aspect in great detail would entail another treatise entirely, but it is generally agreed upon by even the average listener that a record, for example, has an inherently different sound quality than a compact disc or any other digital recording device. This distinction in recording apparatus may account for some or all of the discrepancies.

Other arguments seem to have a place here as well. It is interesting to note that after the 1930's, the lively discussion about tone production, which had been so vibrant for many decades, began to fade. This reduction of scholarship on the subject can be interpreted in two ways. Either pianists and pedagogues alike felt the question was settled, one that really did not need to be discussed further, or they simply became more interested in other elements of piano playing.

The latter reason seems to have at least some bearing on the question. In an age in which piano competitions have all but exhausted their usefulness, an age when even acrobats at the piano have a difficult time selling tickets, an age in which the typical audience, though rarely assembled in great numbers, seems to consist of only three categories: the very old, the musically uneducated, and, classical music's only hope, the classical music students themselves, perhaps pianists feel that concerning themselves with procuring a golden tone is somehow trivial, and the predominance of tone production's mastery has become a thing of the past.

Or has it? Looking at the mastery of such living pianists as Krystian Zimerman or Radu Lupu, perhaps we are in the midst of another Golden Age of piano playing, one that has come about quietly in our faster-paced world. In a world in which classical music is the least of most people's concerns, pianists must face many questions. Does the quest for a beautiful tone really matter? Will a modern audience appreciate it anyway? Perhaps not, but it is at this point that the inspirational story about Michelangelo comes to mind.[140] One day while working with great concern on the back of one his statues that was to be put in the corner of the church, he was asked why he exhausted so much effort on a portion of the statue that no one would see. Without hesitation, he replied, "God will see it."

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[140] As recalled by Berman, *Notes*, 21.

Conclusion:

Tone production is arguably the most important element of piano playing. Not only is the production of a single tone often the first experience of a pianist at his first lesson, but also throughout a pianist's life, tone production occupies utmost priority. Other elements of piano playing can also claim high priority, but tone production is simultaneously the most fundamental and the most complex.

By putting Ortmann's research on tone production into a historical framework, it is clear that it holds an undeniable place in the history of piano scholarship and pedagogy. Unfortunately, his important work has been consistently misunderstood, generalized, or simply ignored.

Using words to explain piano playing is always a difficult and delicate undertaking. Language can be easily misinterpreted; a word that has certain connotations for one person may resonate with another person in a completely different manner. Ortmann's research has suffered criticisms due to this type of misinterpretation, and his words have also been taken out of context. Any piece of literature deserves to be read and studied in full before an evaluation is made. If one reads only the first three pages of James Joyce's *Portrait of the Artist*, one might judge Joyce a terrible writer, but in context, it becomes clear that Joyce is employing a specific technique of style development to mirror the progressing maturity of his protagonist. In the same way, if a sentence is extracted from Ortmann's research, it can sound shocking, unappealing, or plainly harmful. Put back in context, it forms a part of Ortmann's well-rounded and carefully thought out discussion of piano playing.

It is important to note that while Ortmann's studies are scientifically outdated, his findings have not been proven incorrect by any other scientific research to date. They have mostly been attacked because pianists feel that studying piano playing scientifically somehow diminishes the art. In fact, the result is quite the opposite. His research tells us that tone quality is not an elusive gift bestowed only upon specially chosen geniuses; instead, mastering tone quality can be achieved through hard work in key control and pedal manipulation. Knowing that tone quality is a result of key speed, noise regulation and pedaling does not take away from the art; in fact, it adds to the craft. Those who protest Ortmann's conclusions may very well be those who feel their self-perceived elite "genius" is somehow threatened.

Because technology has advanced so much since Ortmann's research was first completed, it seems that now could be the time to investigate these issues yet again. Technology of the 21st century offers so many possibilities, and experiments could now be done with infinitely more precision than they could in 1929. I venture to suggest that even if his calculations are not as precise as they could be, the trends in Ortmann's research would likely be upheld even in a new series of experiments. However, even if he were to be proved wrong on any of his many conclusions by new and scientifically-sound research, he would be the first to heartily agree with the new scientific findings. It is important to remember that it is not only his research in and of itself that deserves mention, but also his tireless dedication to investigation and his desire to shed light on the important principles of piano playing.

One obvious part of tone quality that has not been discussed in depth in this treatise is the role of listening in piano playing. In fact, the aural and mental aspects of tone production are two that many pianists believe are its principal facets. A pianist must first imagine the sound he wants; then after he produces it, he must listen carefully to it to see if he has achieved his ideal. The lack of development of these topics is not a denial of their overwhelming importance, but rather a reflection of Ortmann's research. Since he never completed the last and final book of his trilogy, he was unable to discuss the mental and aural sides of tone production in the way he would have liked.

However, Ortmann's books should be taken for what they are, not for what they are not. First and foremost, they should be read. Because so much of the information is extremely relevant to the modern piano student or teacher, his works should be studied by pianists and pedagogues alike. Ian Johnston, in his book *Measured Tones: The Interplay of Physics and Music*, gives balanced and well-informed advice to pianists and pedagogues alike:

> There was a book published in 1911, by one Tobias Matthay, which lists 42 different ways to play a single note. On the other hand, the physicist looks at the action of the piano and notices that, in the fraction of a second before the hammer hits the string, it has been thrown clear of the mechanism….Some careful experiments done in the 1930s showed that, although notes produced with the same loudness on the same piano always sound exactly the same, notes played with different loudness can have very different timbres. In general, loud notes have more high overtones than soft ones…..Whatever the rights and wrongs of this controversy, and I suspect we haven't heard the last of it, there is a message about the place of science in music. Scientists are slowly increasing our knowledge about some facets of music-making, and musicians should not ignore that knowledge just because it might conflict with some deeply held belief. It seems wrong, for example, that some piano teachers should continue as though the experiments I talked about had never been done. It is difficult enough to learn the right things to do to play a piano well, without learning the wrong things too.[141]

As has been mentioned in the previous chapter, it seems that tone production has lately lost its central standing in pianism, and that many modern pianists place other issues above the quest for an exquisite palette of tone production.

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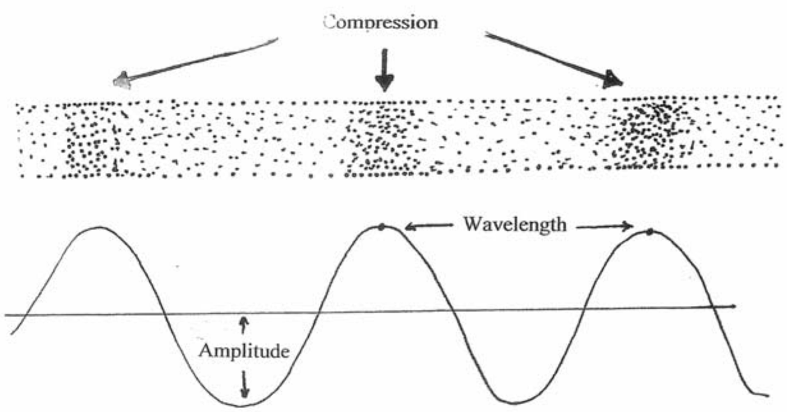
[141] Ian Johnston, *Measured Tones: The Interplay of Physics and Music,* 2nd Ed.*,* (New York: Taylor and Francis, 2002), 85.

Perhaps if Ortmann's works were re-published and his conclusions were properly understood, tone production would again regain its status as the foremost issue in piano playing.

Figures

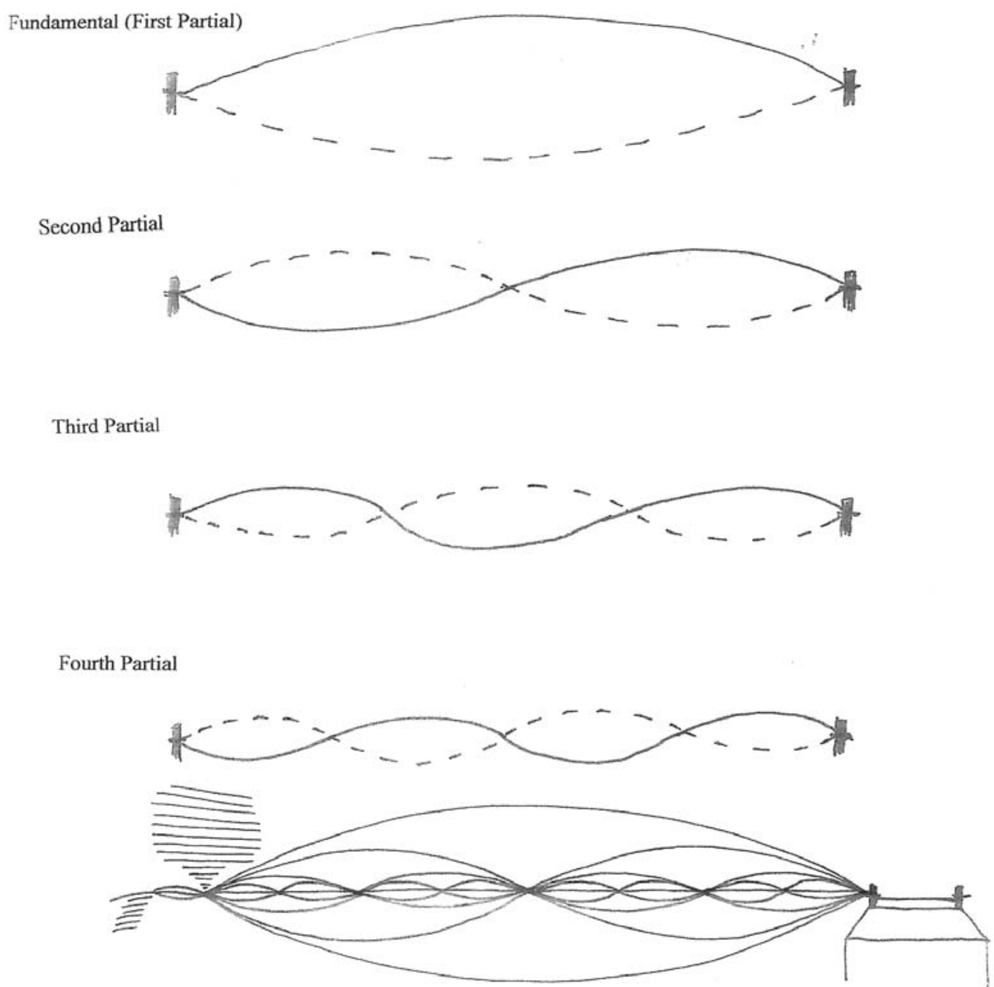
FIGURE 1



Simple Diagram of a Sound Wave

Figure 1

FIGURE 2



Partials in a Vibrating String

Figure 2

FIGURE 3

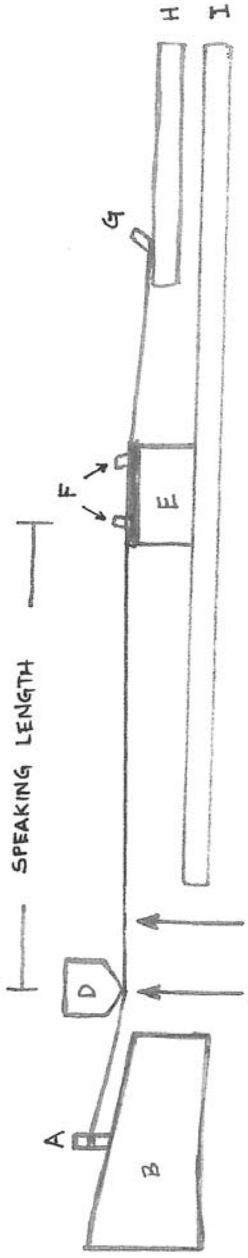
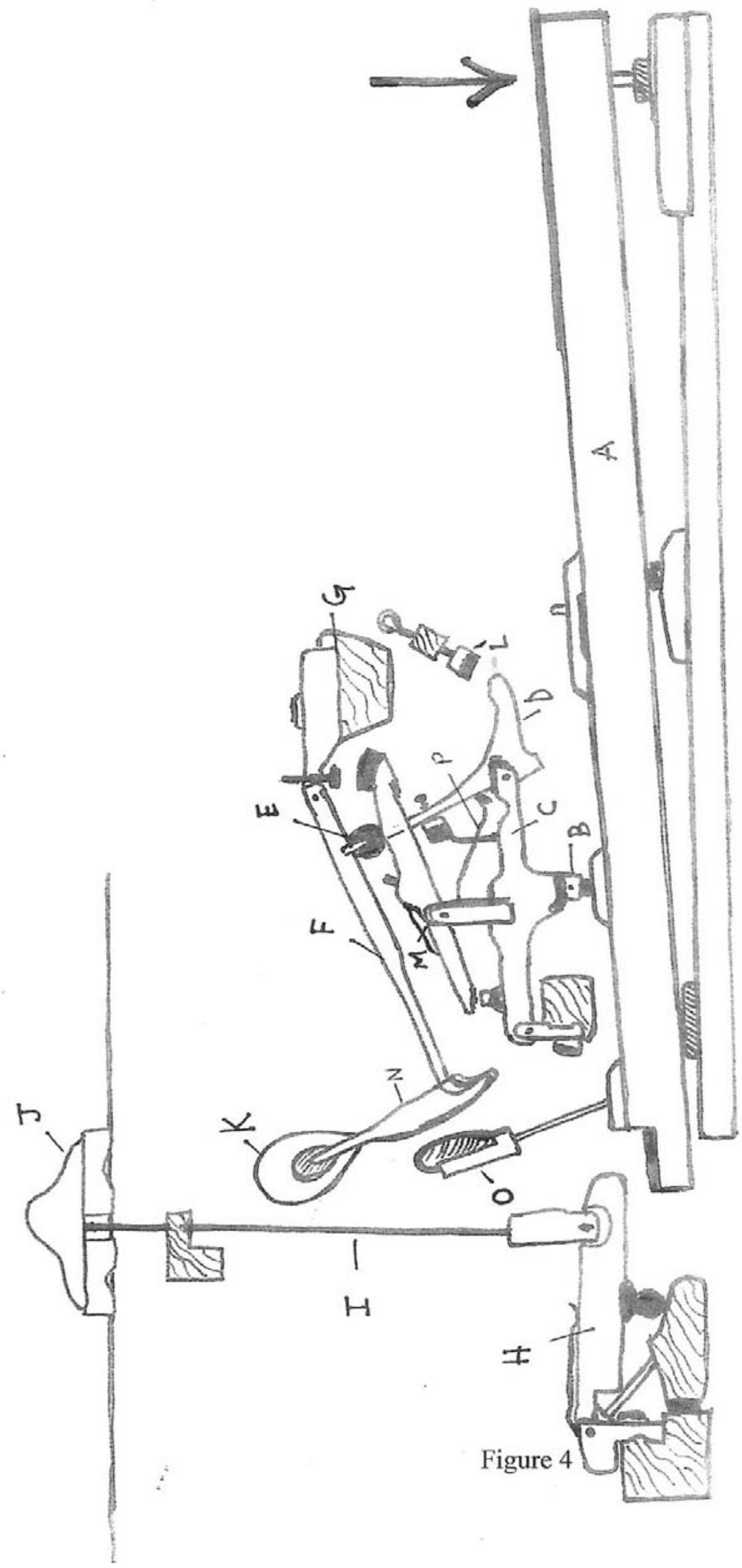


Figure 3

Speaking Length of the String

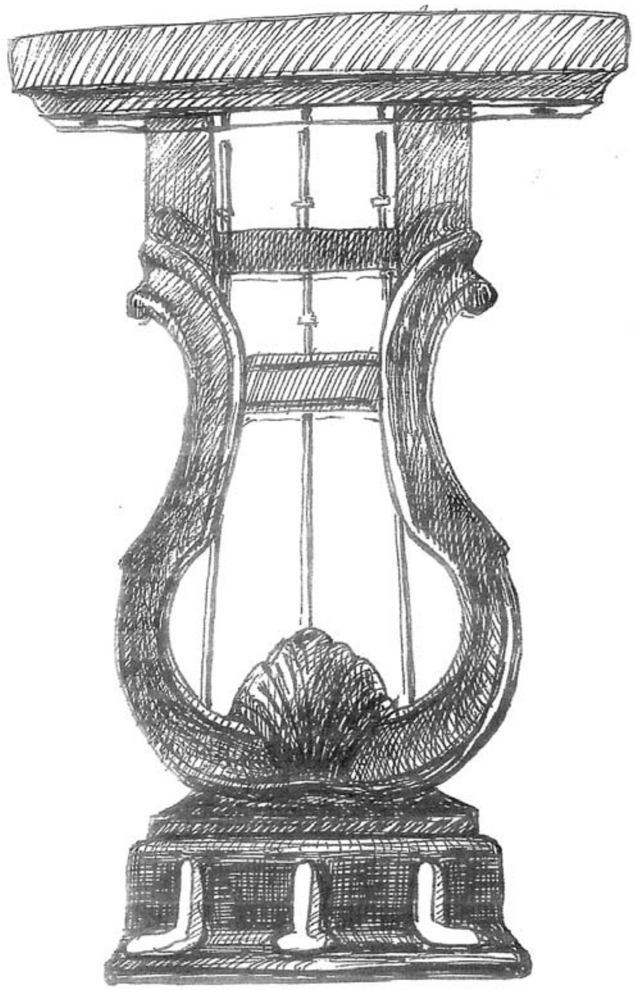
A: Tuning Pin
B: Pin Block
C: Strings
D: Capo Tasto
E: Bridge
F: Bridge Pins
G: Hitch Pin
H: Frame
I: Soundboard
J: Downward Bearing of String on the Bridge
K: Upward Bearing of String on Capo Tasto

FIGURE 4



Action of a Grand Piano

FIGURE 5

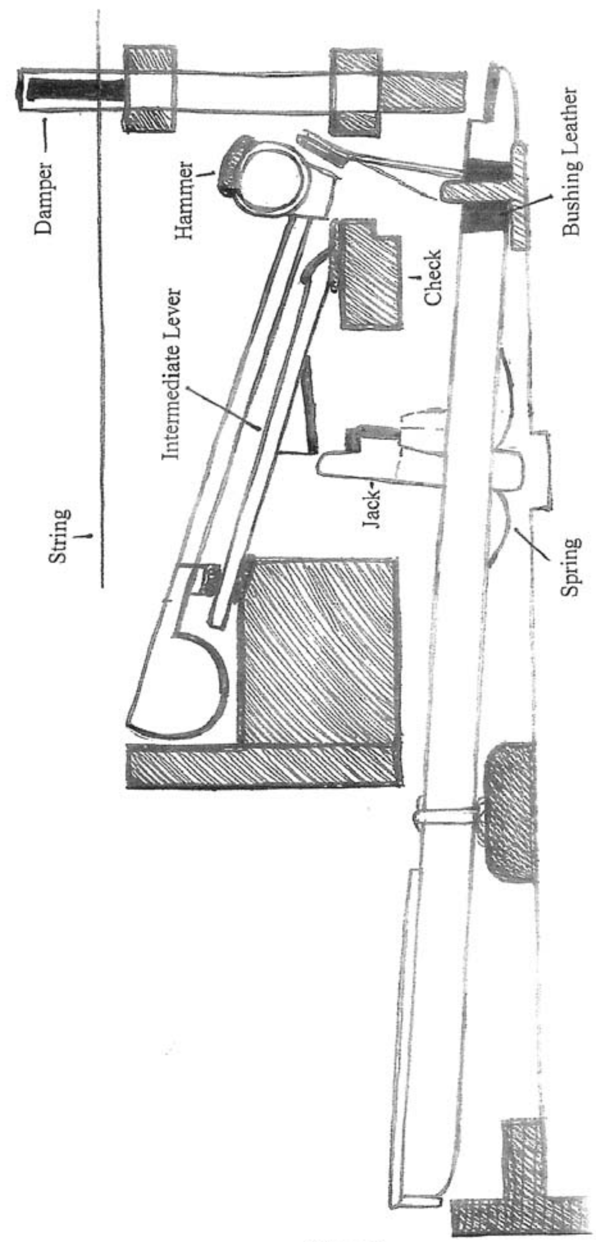


Una Corda Pedal *Sostenuto* Pedal Damper Pedal

The Pedal Lyre of a Grand Piano

Figure 5

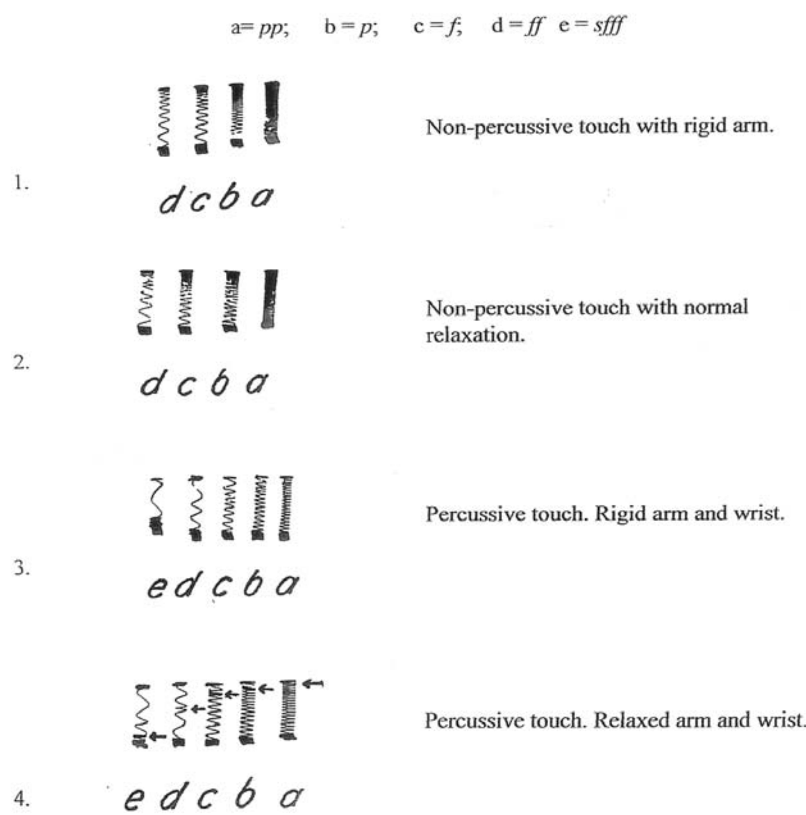
FIGURE 6



Pianoforte Action by Cristofori, 1726

Figure 6

FIGURE 7



Examples of Ortmann's Records of Key Depression

Figure 7

FIGURE 8

Ortmann's List of Definitions

WEIGHT. – That force which a body exerts upon any support which keeps it from falling to the earth. The greater the force, the greater the weight.

MASS. – The amount of matter which a body contains irrespective of its volume or shape.

INERTIA. – The property possessed by a body by means of which a force is necessary to change the motion of the body.

ELASTICITY. – The property of matter by means of which it returns to its original size and shape after deformation under the action of the same force.

RIGIDITY. – That property of matter permitting its shape to be changed only by a great force.

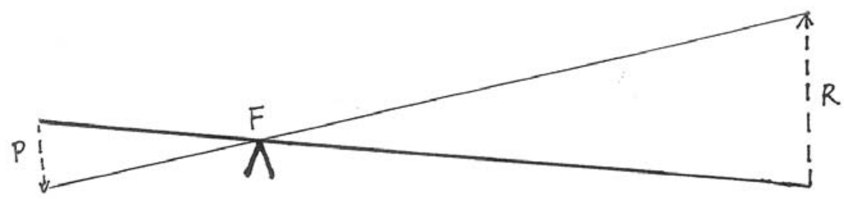
COMPRESSIBILITY. – The property of matter by means of which its volume may easily diminished. The opposite of expandability.

DENSITY. – The mass per unit volume of the substance.

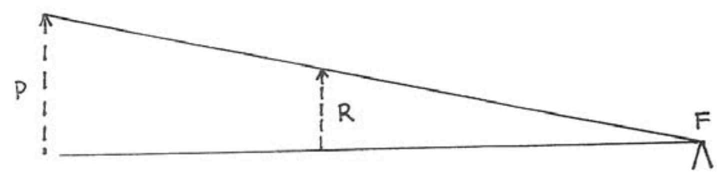
FORCE. – An interaction between two bodies causing of tending to cause a change in the motion of each, either in direction or magnitude.

Figure 8

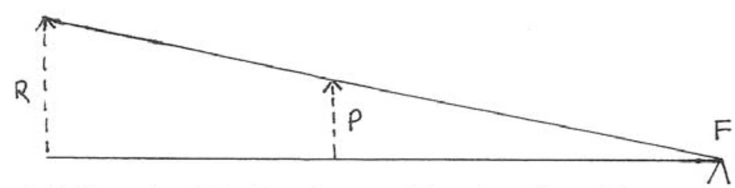
FIGURE 9



Class 1: Fulcrum between the force and the resistance. Example: see saw



Class 2: Resistance between fulcrum and force. Example: wheelbarrow



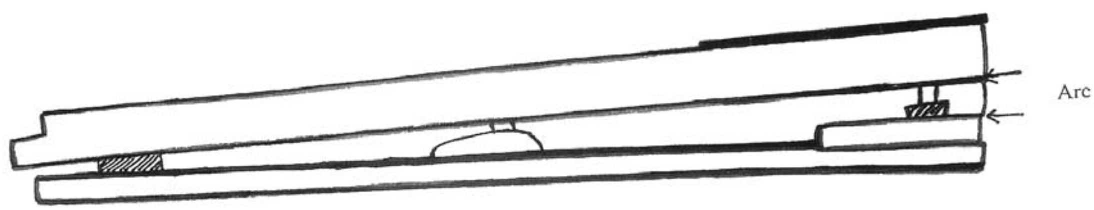
Class 3: Similar to class 2, but the resistance and force have changed places.
Example: draw-bridge

F = Fulcrum
R = Resistance
P = Force

Three Types of Levers

Figure 9

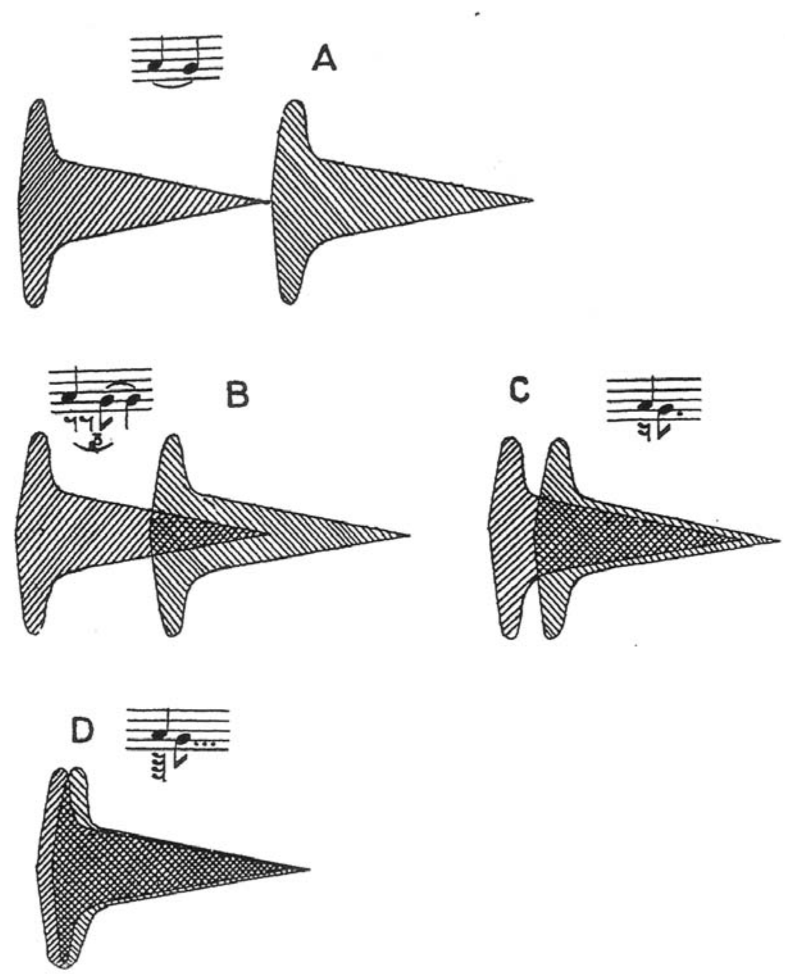
FIGURE 10



Piano Key's Vertical Descent

Figure 10

FIGURE 11



Ortmann's Representation of Overlapping Tones

Figure 11

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Vita

American pianist Amy Elizabeth Gustafson was born in Atlanta, Georgia on August 6, 1981, the daughter of Marjorie Graham Gustafson and Robert Everett Gustafson.

After completing high school at The Stony Brook School, Ms. Gustafson continued her studies in New York City at Manhattan School of Music, earning her Bachelor of Music degree in 2003 under the tutelage of Constance Keene. A year later, she completed her Masters degree at New York University, where she was a scholarship student of Miyoko Nakaya Lotto. She enrolled in the Doctoral program in piano performance at the University of Texas at Austin in the fall of 2005 under the guidance of the acclaimed pianist Anton Nel. She has received several awards, including an honorable mention in the Five Towns Competition, Second Prize in the Joyce Dutka Arts Foundation Competition, and a *Special Presentation Award* from Artists International Presentations.

She has participated in the master classes of some of the world's foremost pedagogues and pianists, including Arie Vardie, Vladimir Feltsman, Horacio Gutierrez, Paul Badura-Skoda, Paul Schenly, Veda Kaplinsky, Martin Canin, Solomon Mikowsky, Luiz de Moura Castro, Boris Slutsky and Julian Martin. In addition, she has participated in numerous music festivals, such as the Aspen Music Festival, Pianofest, the New Millennium International Piano Festival, and the International Keyboard Institute at Mannes College in New York City. Her most recent performances have included recitals in New York City at Steinway Hall, the Tenri Cultural Institute, and CAMI Hall.

Ms. Gustafson, who has taught as a member of the Adjunct Faculty at New York University and has also served as a teaching assistant at The University of Texas, thoroughly enjoys research and scholarship on piano technique and hopes this will be the first publication of many to come on the subject.

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This treatise was typed by the author.